EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-05

☐ Other ☐ Amendment Number:

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016 Base Option Period Number 4	Enhancement of EMPAX_S for NAA

Contractor	Specify Section and paragraph of Contract SOW
RESEARCH TRIANGLE INSTITUTE	Sections 1, 3, 4, 6, 7, 8, 11, 15, 16, 17

Purpose:
- [X] Work Assignment
- [ ] Work Assignment Amendment
- [ ] Work Plan Approval
- [ ] Work Assignment Close-Out
- [ ] Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
WA 4-05 Full Title: Enhancement of EMPAX_S for NAAQS Analyses

This WA continues WA 3-05. See attached SOW. 100 hours are provided for preparation of the work plan and to begin working on the WA.

☐ Superfund — Accounting and Appropriations Data — [X] Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code (Max 7)
1										
2										
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 03/31/2016 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee: — LOE:

Cumulative Approved: — Cost/Fee: — LOE:

Work Assignment Manager Name: Tom Walton (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5311 FAX Number:
Project Officer Name: Jolynn Collins (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5671 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Rodney-Daryl Jones (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3112 FAX Number:

I. TITLE: Enhancement of EMPAX_S for NAAQS Analyses

II. WORK ASSIGNMENT MANAGER (WAM):

Tom Walton
U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards (OAQPS)
Air Economics Group (AEG) (MD-C439-02)
Research Triangle Park, NC 27711
(919) 541-5311 (office) (919) 541-0839 (fax)
walton.tom@epa.gov

Alternate WAM: Larry Sorrels
(919)541-5041 (office) (919)541-5489 (fax)
sorrels.larry@epa.gov

IV. BACKGROUND:

The Environmental Protection Agency (EPA) is currently engaged in revisions of National Ambient Air Quality Standards (NAAQS). EPA must be prepared to model the market and employment impacts of NAAQS. A static version of EMPAX has been partially developed by this contractor in earlier work assignments (most recently contract number EP-W-11-029, work assignment 5). The work performed in this work assignment will not duplicate any work performed in previous contracts or work assignments.

The purpose of this work assignment (WA) is to enhance the model to include a more complete benefit analyses and test the model for alternate ways to incorporate costs.

V. STATEMENT OF WORK (SOW):

The work assignment manager (WAM) is authorized to provide technical direction in accordance with the contract. In accordance with the contract SOW, the Contractor shall perform the following tasks:

Task 1: Prepare Work Plan

The Contractor is required to prepare a work plan for this WA in accordance with the contract. The Contractor shall submit this work plan to the WAM within 20 days of the effective date of the WA. The Contractor shall contact the WAM by phone within 7 days of the effective date of the WA to discuss progress on the work plan.

Task 2: Enhance EMPAX-S

The Contractor shall develop the capability for EMPAX to include benefits, linkages with other models, and alternative approaches to incorporating costs.

Deliverables Under Task 2

2a	Provide plan for model change	No later than 7 weeks after approval of the Work Plan
2b	Revised EMPAX model	Within 6 months after receipt of comments from the WAM on the plan model change

Task 3: Model Testing

The contractor shall develop a plan to investigate model performance for incorporating benefits, linking to other models, and incorporating cost.

The contractor shall carry out the plan after approval of the plan by the WAM

Deliverables Under Task 3

3a	Prepare a plan to investigate the issues described above.	No later than 2 weeks after receipt of technical direction from the WAM
3b	Prepare Final Report on the results	No later than 2 months after receipt of comments from the WAM

VI. REPORTING REQUIREMENTS:

With any analysis provided to EPA, the Contractor shall provide an assessment of the quality and appropriateness of any data used in the analysis.

All reports shall be in accordance with contract specifications. In addition, for draft deliverables, two hard copies shall be delivered to the WAM if requested for review and comments and the draft report shall be emailed to the WAM. For final report deliverables, the report shall be emailed to the WAM and three copies shall be delivered to the WAM with an accompanying master copy in both hardcopy and electronic format on a CD-ROM as necessary (a searchable PDF in Adobe Acrobat 7.0 or higher, if requested by WAM, and MS Word 2007 format or higher). Draft and final tabular data or programs shall be delivered in the appropriate electronic format (i.e., Excel spreadsheet, or other) as requested by the EPA WAM. All software files provided to the WAM during the course of this WA shall be free of all known computer viruses, spyware, and malware prior to delivery.

The Contractor shall also contact the WAM once per week by phone after receipt of the work assignment after to discuss progress on the tasks included therein. This requirement is in addition to required phone call stated in Task 1.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-05

☐ Other ☒ Amendment Number: 000001

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016	Enhancement of EMPAX S for NAA
	Base Option Period Number 4	

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
THIS WA AMENDED TO CHANGE WORK ASSIGNMENT MANAGER FROM TOM WALTON TO ALEX MACPHERSON. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code (Max 7)
1										
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Authorized Work Assignment Ceiling

	Contract Period:	Cost/Fee:	LOE:
	04/01/2011 To 03/31/2016		
This Action:			
Total:			

Work Plan / Cost Estimate Approvals

Contractor WP Dated:	Cost/Fee:	LOE:
Cumulative Approved:	Cost/Fee:	LOE:

Work Assignment Manager Name: Alex Macpherson (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-9770 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Rodney-Daryl Jones (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3112 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-05

☐ Other ☒ Amendment Number: 000002

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016 Base Option Period Number 4	Enhancement of EMPAX S for NAA

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
This WA amended to change the Alternate COR from Larry Sorrels to Linda Chappell.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 03/31/2016 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Alex Macpherson (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-9770 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Rodney-Daryl Jones (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3112 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-05

☐ Other ☒ Amendment Number: 000003

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 09/30/2016 Base Option Period Number 4	Enhancement of EMPAX for NAA

Contractor	Specify Section and paragraph of Contract SOW
RESEARCH TRIANGLE INSTITUTE	1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
Two actions: (1) change signature lines in EAS for current PO and CO; (2) inform Contractor that hours/cost will be decreased to what actually used (decrease from 552 hours to 285 hrs/Cost_Fee decrease from $63,076 to $60,974).

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
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Authorized Work Assignment Ceiling

	Cost/Fee	LOE
Contract Period: 04/01/2011 To 09/30/2016		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Alex Macpherson	(Signature)	(Date)	Branch/Mail Code: Phone Number: 919-541-9770 FAX Number:
Project Officer Name: Carolyn Blake	(Signature)	(Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: Judy Ancharski	(Signature)	(Date)	Branch/Mail Code: Phone Number: 919-541-5586 FAX Number:
Contracting Official Name: Andrew Flynn	(Signature)	(Date)	Branch/Mail Code: Phone Number: 919-541-2674 FAX Number: 919-541-0611

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-04

☐ Other ☒ Amendment Number: 000004

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 09/30/2016 Base Option Period Number 4	Air Deposition to Freshwater .

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: Sections 3 and 4

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 07/31/2015 To 09/30/2016

Comments:
THIS AMENDMENT TO LIFT BUDGETARY CAP AND TO CHANGE CO FROM MARSHA JOHNSON TO ANDREW FLYNN.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

SFO (*Max 2*) ☐

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
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Authorized Work Assignment Ceiling

	Cost/Fee:	LOE:
Contract Period: 04/01/2011 To 09/30/2016		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE:
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Randy Waite (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5447
	FAX Number:	
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5256
	FAX Number:	
Other Agency Official Name (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	
	FAX Number:	
Contracting Official Name: Andrew Flynn (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-2674
	FAX Number:	919-541-0611

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-04

☐ Other ☒ Amendment Number: 000005

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 05/31/2017	Air Deposition to Freshwater
	Base Option Period Number 4	

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: Sections 3 and 4

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 07/31/2015 To 05/31/2017

Comments:
THIS AMENDMENT IS TO EXTEND THE CURRENT OPTION PERIOD FOR 8 MONTHS (ENDING 5/31/2017). CONTRACTOR SHALL PROCEED WITH WORK ASSIGNMENT, REVISING COST ESTIMATE IF NEEDED. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
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Authorized Work Assignment Ceiling

	Cost/Fee:	LOE:
Contract Period: 04/01/2011 To 05/31/2017		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE:
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Randy Waite (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5447 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Andrew Flynn (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2674 FAX Number: 919-541-0611

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-04

☐ Other ☒ Amendment Number: 000006

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 09/30/2019 Base Option Period Number 4	Air Deposition to Freshwater

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW: Sections 3 and 4

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 07/31/2015 To 05/31/2017

Comments:
SOW amended (see attachment) to add tasks to the SOW. Contractor shall prepare a revised work plan/cost estimate in response to these changes. 100 hours added to WA for preparation of revised Work Plan/continue work. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
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Authorized Work Assignment Ceiling

	Contract Period:	Cost/Fee:	LOE:
	06/01/2017 To 09/30/2019		
This Action:			
Total:			

Work Plan / Cost Estimate Approvals

Contractor WP Dated:		Cost/Fee	LOE:
Cumulative Approved:		Cost/Fee	LOE:

Work Assignment Manager Name: Randy Waite (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5447
	FAX Number:	
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5256
	FAX Number:	
Other Agency Official Name (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	
	FAX Number:	
Contracting Official Name: Christopher Davis (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-4609
	FAX Number:	919-685-3415

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-06

☐ Other ☐ Amendment Number:

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 09/30/2019 Base Option Period Number 4	Incorporating Multi-Pollutant

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW: Sections 10, 11, 12, 13

Purpose:
- [X] Work Assignment
- [ ] Work Assignment Amendment
- [ ] Work Plan Approval
- [ ] Work Assignment Close-Out
- [ ] Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:

WA 4-06 Full Title: Incorporating Multi-Pollutant Functionality into the BenMAP-CE Tool

This WA continues WA 3-06. See attached SOW. 400 hours are provided for preparation of the work plan and

☐ Superfund — Accounting and Appropriations Data — [X] Non-Superfund

SFO (*Max 2*): ☐

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
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Authorized Work Assignment Ceiling

	Contract Period:	Cost/Fee:	LOE:
	04/01/2011 To 09/30/2019		
This Action:			
Total:			

Work Plan / Cost Estimate Approvals

Contractor WP Dated:	Cost/Fee	LOE:
Cumulative Approved:	Cost/Fee	LOE:

Work Assignment Manager Name: Neal Fann (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-0209 FAX Number:
Project Officer Name: Jolynn Collins (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5671 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Rodney-Daryl Jones (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3112 FAX Number:

WORK ASSIGNMENT
ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

I. TITLE

"Incorporating Multi-Pollutant Functionality into the BenMAP-CE Tool"

II. WORK ASSIGNMENT MANAGER (WAM):

Neal Fann
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division (C539-07)
Research Triangle Park, NC 27711
Phone: (919) 541-0209

Alternate WAM:

Phil Morefield
U.S. Environmental Protection Agency
Office of Research and Development
National Center for Environmental Assessment (8601P)
2733 Crystal Drive
Arlington, VA 22202

III. SUMMARY

The purpose of this Work Assignment is to further improve the environmental Benefits Mapping and Analysis Program—Community Edition (BenMAP-CE) by initiating the multi-pollutant related tasks first outlined in Work Assignment 3-06. Under Work Assignment 3-06, the Contractor incorporated a module that employs data from the 2010 Global Burden of Disease tool to quantify the number of fine-particle related deaths in each country in the world; validate input data; and, report errors to the development team. Under this work assignment, the contractor will enable the tool to quantify the human health effects from two or more pollutants or stressors.

IV. PROJECT BACKGROUND

In 2003 the U.S. EPA contracted with a developer to create version 1.0 of the environmental Benefits Mapping and Analysis Program (BenMAP). That tool systematized a number of the steps of a health impact and benefits analysis that had previously been performed using a series of linked spreadsheets. Subsequent versions incorporated a number of new features, including a database that could be modified by end-users, more spatially resolved baseline health data and a broader array of health impact functions. The U.S. EPA has used BenMAP to estimate the avoided human health impacts and economic benefits of a number of air quality policies, including the 2002 Non-

Road Diesel rule, the 2004 Clean Air Interstate Rule, and the 2011 Mercury and Air Toxics rules, among many others. Over 50 researchers have published over 25 journal articles using BenMAP.

Beginning in 2011, the U.S. EPA began redeveloping the tool from the ground-up to meet two goals: (1) create an open-source software platform so that anyone could see the software code and improve the program; (2) improve the performance, accessibility, capabilities and usability of the software. In the Fall of 2013, after iterating through dozens of beta versions, the U.S. EPA released version 1.0 of the environmental Benefits Mapping and Analysis Program—Community Edition (BenMAP-CE). While version 1.0 met the first of these two goals, attaining the second will require additional effort on the part of U.S. EPA and its partners.

Specific activities and tasks supported by this funding are described below, along with the project timeline and budget. In accordance with the contract and as directed by the WAM, the Contractor shall provide all data (including software and programming code) obtained and developed under this work assignment. Data shall be delivered in complete form, in the media and format directed by the WAM. The Contractor shall not use proprietary software in BenMAP-CE.

V. STATEMENT OF WORK

Specific activities and tasks, as well as the schedule for deliverables are outlined below.

Task 1: Develop a work plan and project plan

The Contractor shall develop a new work plan and update the system design document as described below.

Task 1.a: Develop work plan and administer project

Within 20 calendar days of the effective date of this WA, the Contractor shall submit a work plan to the Work Assignment Manager (WAM). The Contractor shall arrange and conduct an initial phone conference with the WAM within one week of the WAM approving the WA. Subsequent to this initial teleconference, the Contractor shall lead regular phone conferences on at least a weekly basis to discuss work progress and any issues associated with the work tasks. The Contractor shall prepare an agenda for such weekly meetings, record meeting minutes, and distribute such meeting minutes to all participants.

Task 1.b: Update the system design document

The Contractor, consulting with the WAM, shall continue developing the comprehensive and detailed project plan for each task in this WA begun under Work Assignment 2-26, specifying clearly the technical and functional basis for the new version:

- The minimum design characteristics of the new software

- A workflow describing the expected inputs and outputs of each new program algorithm, including example use cases.
- Desired behavior of graphical the graphic user interface, including sketches of windows, location of hover text, etc.
- Protocol for quality assuring each new feature.
- Sequence in which the Contractor will address the tasks below.

The Contractor shall not modify the source code until the WAM approves this project plan. The Contractor shall develop the system design document for each new BenMAP-CE feature on a rolling basis and in consultation with the Work Assignment Manager.

Deliverables:

1.1. Work plan
1.2. System design document

Task 2: Identify additional GIS-based health impact modules

Continuing work begun under Work Assignment 3-06, the Contractor shall assess the extent to which the DotSpatial GIS software may be scaled and adapted to support future health impact modules. In particular, the Contractor shall consider the ability of the GIS to assess the human health impacts of water quality and vector-borne illnesses, as well as recreational and residential visibility. The contractor shall investigate the feasibility of addressing: (1) vector-borne diseases from ticks; (2) increased incidence of adverse health outcomes due to elevated rainfall from extreme weather events. For each stressor, the Contractor shall:

- Detail the input data needed to quantify those stressors—including environmental, population, health and stressor-response relationships. The Contractor shall consult the literature review performed to support the National Climate Assessment to identify candidate studies that may be used to create stressor-response functions.
- Describe the changes, if any, needed to the BenMAP-CE tool to calculate these impacts—including changes to the GIS, database, reports and audit trail. Where necessary, the Contractor shall amend the system design document to reflect these program changes.
- Upon the approval of the WAM, the Contractor shall modify the BenMAP-CE tool to assess one to two test cases.
- To the extent that the Contractor has developed a viable approach for quantifying these impacts in BenMAP-CE, the Contractor shall develop one or two proof-of-concept test cases, to be documented in a memorandum.

Deliverables:

2.1 GIS health impact module final report
2.2 Detailed GIS health impact module report
2.3 Modify the BenMAP-CE tool to quantify one to two environmental stressors

2.4 Health impact memorandum

Task 3: Incorporate New Multi-Pollutant and Multi-Stressor Algorithms

The Contractor shall modify the BenMAP-CE algorithms in two key ways: (1) allow users to specify multiple effect coefficients and air quality (or stressor) changes in the program; (2) enable users to assign health impact functions to discrete geographic areas.

Task 3.a: Multi-pollutant health impact functions

The Contractor shall modify the BenMAP-CE program so that it can estimate the joint health impacts associated with changes in more than one pollutant or stressor (e.g. temperature). Specifically, BenMAP-CE will be able to:

- Incorporate more than one set of baseline and control air quality or stressor files
- Incorporate more than one effect coefficient in the health impact function editor (e.g. specify a health impact function which has two pollutants with separate effect coefficients and an interaction coefficient)
- Be able to process complex health impact functions with multiple forms, including (but not limited to) quadratic functions, conditional functions, splines and daily thresholds.
- Quantify an uncertainty distribution for a multi-pollutant health impact function using the variance/co-variance matrix specified in the epidemiological study supplying the effect coefficient.
- Report and map changes in air quality and stressors and health impacts.

The changes above will require the Contractor to modify both the user interface and program logic extensively. The Contractor shall both reference the system design document (described above) and consult regularly with the WAM when making these changes. The WAM will provide the Contractor with one or more examples of the algorithm in SAS or R. One or more EPA biostatisticians and air pollution epidemiologists will participate in the project team and serve as a technical resource to the Contractor.

Task 3.b: Applying health impact functions by geographic area

The Contractor shall modify the BenMAP-CE program so that users can apply a health impact function to a discrete geographic location—for example, a region, state or county. The Contractor shall modify BenMAP-CE so that it:

- Allows users to assign a function to a specific geographic area within either the function editor or "on the fly" using the BenMAP-CE GIS.
- Estimates health impacts only for each location to which that health impact function is assigned.

- Can import a user-provided spreadsheet of health impact functions assigned to discrete geographic areas
- Reports clearly the health impact estimates in the report window and GIS for each geographic area.

As above, these changes will require the Contractor to modify both the user interface and program logic extensively. For these reasons, the Contractor shall reference closely the system design document and consult regularly with the WAM. The Contractor shall also identify epidemiological studies performed for a subset of countries identified by the WAM, develop health impact functions for these countries, and load these data into the BenMAP-CE database. And, as above, the Contractor shall perform one or more test cases to be reviewed by the WAM.

The Contractor shall not modify the source code until the WAM approves this project plan.

Task 3.c: Test the new features

Upon modifying the BenMAP-CE program as described above to estimate multi-pollutant health impact functions, and assign health impact functions to discrete geographic areas, the Contractor shall evaluate these features using two to three test cases specified by the WAM. Specifically, the Contractor shall:

- Quantify multi-stressor and multi-pollutant health impacts using WAM-specified epidemiological studies and WAM-supplied air quality surfaces
- Apply city-specific risk coefficients in a health impact analysis using WAM-specified epidemiological studies and WAM-supplied air quality surfaces
- Assist the WAM in documenting these results for a manuscript that will be submitted for peer review. This manuscript will describe the key methodological differences in using this approach as compared to traditional health impact assessments. The manuscript shall also characterize the influence of key analytical inputs and assumptions to create a matrix of factors that most influence the size and distribution of health impacts.

Deliverables:

3.1 Draft multi-pollutant health impact function feature
3.2 Final multi-pollutant health impact function feature
3.3 Draft location-specific health impact function feature
3.4 Final location-specific health impact function feature
3.5 Document changes to user interface and new algorithms in the user manual
3.6 Test cases performed
3.7 Manuscript for peer review

Quality Assurance

The Contractor shall identify or include references of where to find the quality assurance criteria (e.g., data completeness minimum number of observations) that will be or that was applied to the data used in this work assignment. The implemented quality assurance procedures, data sources (and data acquisition date), explanation of the appropriateness of the data for the intended use and other pertinent data qualifications shall be stipulated in all deliverables produced via this work assignment.

VI. REPORTING REQUIREMENTS

1. The Contractor shall submit a detailed cost estimate within fourteen calendar days of the effective date of this work assignment. The estimated cost shall include direct labor, overhead, consultant and subcontractor fee, other direct costs, and estimated total fee.
2. The Contractor shall submit monthly progress reports in accordance with the contract.
3. During the period of performance of this contract, the Contractor shall inform the WAM immediately (by telephone and email) of any problem(s) that may impede performance, as well as corrective actions needed from the Contractor and the EPA to resolve the problem(s).

VII. DELIVERABLES AND SCHEDULE

Task number	Task Name	Deadline	Notes
1.1	Work plan	Within 20 days of effective date	
1.2	System design document	Developed throughout duration of work assignment	System design document will specify sequence of BenMAP-CE improvements below. WAM will specify deliverable date for each task.
2.1	GIS health impact module final report	June 1st	
2.2	Detailed GIS health impact module final report	July 1st	
2.3	Modify BenMAP-CE to quantify one or two stressors	August 1st	
2.4	Health impact memorandum	September 1st	
3.1	Draft multi-pollutant feature	August 1st	
3.2	Final multi-pollutant feature	November 1st	
3.3	Draft location-specific feature	December 15th	

Task number	Task Name	Deadline	Notes
3.4	Final location-specific feature	February 1st	
3.5	Update the user manual	Developed throughout duration of work assignment	
3.6	Test cases	February 15th	
3.7	Manuscript for peer review	March 15th	

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-06

☐ Other ☒ Amendment Number: 000001

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 09/30/2016 Base Option Period Number 4	Incorporating Multi-pollutant

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 8

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 09/30/2016

Comments:
THIS AMENDMENT IS TO EXTEND THE CURRENT OPTION PERIOD (4), PERIOD OF PERFORMANCE, FOR 6 MONTHS (ENDING 9/30/2016). CONTRACTOR SHALL PROCEED WITH WORK ASSIGNMENT, REVISING COST ESTIMATE IF NEEDED. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

	Contract Period:	Cost/Fee:	LOE:
	04/01/2011 To 09/30/2016		
This Action:			
Total:			

Work Plan / Cost Estimate Approvals

Contractor WP Dated:	Cost/Fee	LOE:
Cumulative Approved:	Cost/Fee	LOE:

Work Assignment Manager Name: Neal Fann (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-0209 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Marsha B. Johnson (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-0952 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-06

☐ Other ☒ Amendment Number: 000002

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 05/31/2017 Base X Option Period Number	Incorporating Multi-Pollutant

Contractor	Specify Section and paragraph of Contract SOW
RESEARCH TRIANGLE INSTITUTE	8

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2017

Comments:
THIS AMENDMENT IS TO EXTEND THE CURRENT OPTION PERIOD FOR 8 MONTHS (ENDING 5/31/2017), AND TO CHANGE CO TO CHRISTOPHER DAVIS. CONTRACTOR SHALL PROCEED WITH WORK ASSIGNMENT, REVISING COST ESTIMATE IF NEEDED. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

Contract Period:	Cost/Fee:	LOE:
04/01/2011 To 05/31/2017		
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Total:		

Work Plan / Cost Estimate Approvals

Contractor WP Dated:	Cost/Fee	LOE:
Cumulative Approved:	Cost/Fee	LOE:

Work Assignment Manager Name: Neal Fann (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-0209 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christopher Davis (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-4609 FAX Number: 919-685-3415

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-06

☐ Other ☒ Amendment Number: 000003

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 05/31/2017 Base Option Period Number 4	Incorporating Multi-Pollutant

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 8

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2017

Comments:
THIS PROJECT IS COMPLETE. THEREFORE, THIS AMENDMENT IS ISSUED TO STOP WORK ON THIS PROJECT.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

	Cost/Fee:	LOE:
Contract Period: 04/01/2011 To 05/31/2017		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE:
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Neal Fann (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-0209 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christopher Davis (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-4609 FAX Number: 919-685-3415

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☐ Amendment Number:

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016 Base Option Period Number 4	Revisions and Improvements to

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: Sections 19

Purpose:
- ☒ Work Assignment
- ☐ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:

WA 4-07 Full Title: Revisions and Improvements to the EPA Air Pollution Control Cost Manual

Continuation of WA 3-07. See attached SOW. 300 hours are provided for preparation of the work plan and to begin working on the WA.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code (Max 7)
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Authorized Work Assignment Ceiling

	Contract Period:	Cost/Fee:	LOE:
This Action:	04/01/2011 To 03/31/2016		
Total:			

Work Plan / Cost Estimate Approvals

Contractor WP Dated:	Cost/Fee:	LOE:
Cumulative Approved:	Cost/Fee:	LOE:

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5041 FAX Number:
Project Officer Name: Jolynn Collins (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5671 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Rodney-Daryl Jones (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3112 FAX Number:

Statement of Work

I. TITLE: Revisions and Improvements to the EPA Air Pollution Control Cost Manual

II. CONTRACTOR: Research Triangle Institute (RTI)

III. WORK ASSIGNMENT CONTRACTING OFFICER REPRESENTATIVE (WACOR):

Larry Sorrels
U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, MD: C439-02
Research Triangle Park, NC 27711
(919) 541-5041 (office) (919) 541-0839(fax)
sorrels.larry@epa.gov

Alternate WACOR: David Misenheimer
U. S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, MD: C439-02
Research Triangle Park, NC 27711
919-541-5473 (office) (919) 541-0839 (fax)
misenheimer.david@epa.gov

IV. BACKGROUND:

The Air Economics Group (AEG) is responsible for maintaining the EPA Air Pollution Control Cost Manual (henceforth the "Cost Manual"), a document that provides guidance to EPA and others for preparing cost analyses of installation and operation of add-on or end-of-pipe pollution control equipment. This document has existed since the 1980's and has served as a key basis for cost analyses done by EPA for many different rulemakings and has been a foundation for guidance including costs in the course of permit review by EPA and States. The Cost Manual has been well used for such purposes, and has become an important source of information for these purposes over many years. The Cost Manual has not been updated for a number of years (not since 2003), and the purpose of the current work assignment (WA) is to provide for revisions to update this document. In particular, the revisions in this work assignment will focus on preparing revisions in response to public comments on the SNCR and SCR draft chapters that have been prepared by this Contractor under previous work assignments, to prepare revised VOC control chapters for internal EPA workgroup review and to respond to public comments on the revised VOC control chapters, and to begin work on revising the SO2 control chapters. The Contractor shall not duplicate work previously performed.

V. STATEMENT OF WORK (SOW):

The WACOR is authorized to provide technical direction in accordance with the contract. In accordance with the contract SOW, the contractor shall perform the following tasks:

Task 1: Prepare Work Plan and Other Administrative Requirements

The Contractor shall prepare a work plan and submit this to the WACOR. The Contractor shall have conference calls with the WACOR on, at least, a monthly basis after approval of the work plan to plan and review progress of this WA.

Deliverables Under Task 1

1a Work plan: Within twenty days of the effective date of this WA.

Task 2: Revise EPA Air Pollution Control Cost Manual Chapters

In accordance with task 19 of the contract SOW, the Contractor shall revise various chapters in the EPA Air Pollution Control Cost Manual. These revisions include changes to the contents of the existing document and/or additional appendices as needed to address internal or external issues with data or methodologies employed by the Agency. Revisions shall be completed for the existing SNCR and SCR chapters prepared by this contractor. In addition, the Contractor shall prepare revisions to the VOC control chapters, beginning with the Incinerators chapters and then progressing to all of the other three VOC chapters. It should be noted that work to complete the SNCR and SCR chapters may coincide with work on revising the VOC chapters. Finally, the Contractor shall begin work on revising the SO2 chapter (wet scrubbers).

The EPA WACOR will initiate the process of revising the Cost Manual by providing technical direction for revising the draft Cost Manual and the schedule for completion of the required revisions.

Deliverables Under Task 2

2a Draft Revisions to Each Chapter: Within 1 month of receiving technical direction or in consultation with the EPA WACOR. Such revisions may originate with public comments or from the EPA workgroup formed to aid in development of the Control Cost Manual update. The WACOR will review and provide comments within 14 days.

2b Final Revisions: Within 3 weeks of receiving comments from WACOR.

VI. REPORTING REQUIREMENTS:

All reports shall be in accordance with contract specifications. Deliverables shall be provided to the WACOR in electronic format with an accompanying master copy in hard copy format if requested by the WACOR. Deliverables shall also be provided as appropriate in the following software formats: PDF, Word format, or Excel spreadsheets. Electronic files provided to the WACOR during the course of this WA shall be free of all known computer viruses, spyware and malware prior to delivery to the WACOR.

In addition, the Contractor shall include in any final deliverable a section regarding quality assurance with data used with respect to precision, accuracy, representativeness, comparability, completeness, sensitivity, and appropriateness.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000001

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016 Base Option Period Number 4	Revisions & Improvements to

Contractor	Specify Section and paragraph of Contract SOW
RESEARCH TRIANGLE INSTITUTE	19

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
This work assignment amended to lift budgetary cap. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code (Max 7)
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Authorized Work Assignment Ceiling

Contract Period:	Cost/Fee:	LOE:
04/01/2011 To 03/31/2016		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee:	LOE:
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5041 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Rodney-Daryl Jones (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3112 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000002

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 09/30/2016 Base Option Period Number 4	Revisions & Improvements...

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 19

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 09/30/2016

Comments:
THIS AMENDMENT IS TO EXTEND THE CURRENT OPTION PERIOD (4), PERIOD OF PERFORMANCE, FOR 6 MONTHS (ENDING 9/30/2016). CONTRACTOR SHALL PROCEED WITH WORK ASSIGNMENT, REVISING COST ESTIMATE IF NEEDED. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

SFO (*Max 2*) ☐

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 09/30/2016 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5041 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Marsha B. Johnson (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-0952 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000003

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 09/30/2016 Base Option Period Number 4	Revisions & Improvements...

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: Task 19

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 09/30/2016

Comments:
SOW AMENDED TO ADD SUB-TASK TO TASK 2 OF WA (see attachment). CONTRACTOR SHALL PREPARE A REVISED WORK PLAN/COST ESTIMATE IN RESPONSE TO THIS CHANGE. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

	Contract Period:	Cost/Fee:	LOE:
	04/01/2011 To 09/30/2016		
This Action:			
Total:			

Work Plan / Cost Estimate Approvals

Contractor WP Dated:		Cost/Fee	LOE:
Cumulative Approved:		Cost/Fee	LOE:

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5041
	FAX Number:	
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5256
	FAX Number:	
Other Agency Official Name (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	
	FAX Number:	
Contracting Official Name: Marsha B. Johnson (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-0952
	FAX Number:	

WAM: Larry Sorrels, OAQPS/HEID/AEG

WAM Phone Number: 919-541-5041

WAM E-mail address: sorrels.larry@epa.gov

Date: 4/7/16

Work Assignment 4-07, Modification 4

Work Assignment Title: Revisions and Improvements to the EPA Air Pollution Control Cost Manual

Statement of Work:

This modification to the work assignment is to add a sub-task to Task 2 of the work assignment. These sub-tasks are as follows:

Sub-Task 8: Spreadsheets for revised VOC control measure chapters and for the wet scrubbers chapter

Under this sub-task, the Contractor shall prepare draft and final versions of spreadsheets for the Incinerators/Oxidizers, Condensers, Carbon Adsorbers, Flares, and Wet Scrubbers chapters. These spreadsheets shall include all relevant cost and performance information from these chapters to allow for estimating capital, annual cost, and emission reductions for applying these control technologies at a unit-level. The format of these spreadsheets shall use the format of the spreadsheets prepared for the revised SNCR and SCR Cost Manual chapters under this work assignment as a basis.

Schedule for Deliverables: Each draft spreadsheet shall be prepared within 3 weeks of preparation of the final draft chapter, which is the draft that includes responses to comments from the WAM (or "EPA", in the shorthand of the work assignment). Final spreadsheets shall be prepared within 1 month of receipt of comments from the WAM but no later than September 30, 2016.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000004

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 05/31/2017 Base Option Period Number 4	Revisions & Improvements

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 8

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2017

Comments:
THIS AMENDMENT IS TO EXTEND THE CURRENT OPTION PERIOD FOR 8 MONTHS (ENDING 5/31/2017), AND TO CHANGE CO TO ANDREW FLYNN. CONTRACTOR SHALL PROCEED WITH WORK ASSIGNMENT, REVISING COST ESTIMATE IF NEEDED. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

SFO (*Max 2*) ☐

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 05/31/2017 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5041 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Andrew Flynn (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2674 FAX Number: 919-541-0611

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000004

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 05/31/2017 Base Option Period Number 4	Revisions & Improvements

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 8

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2017

Comments:
THIS AMENDMENT IS TO EXTEND THE CURRENT OPTION PERIOD FOR 8 MONTHS (ENDING 5/31/2017), AND TO CHANGE CO TO ANDREW FLYNN. CONTRACTOR SHALL PROCEED WITH WORK ASSIGNMENT, REVISING COST ESTIMATE IF NEEDED. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

SFO (*Max 2*) ☐

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 05/31/2017 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5041 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Andrew Flynn (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2674 FAX Number: 919-541-0611

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000005

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 11/30/2017 Base Option Period Number 4	Revisions & Improvements

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 8

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 11/30/2017

Comments:
THIS AMENDMENT IS TO EXTEND THE CURRENT OPTION PERIOD (4) FOR 6 MONTHS (ENDING 11/30/2017). CONTRACTOR SHALL PROCEED WITH WORK ASSIGNMENT, REVISING COST ESTIMATE IF NEEDED. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

SFO (*Max 2*) ☐

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

	Cost/Fee:	LOE:
Contract Period: 04/01/2011 To 11/30/2017		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE:
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5041 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christopher Davis (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-4609 FAX Number: 919-685-3415

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000006

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 11/30/2017 Base Option Period Number 4	Revisions & Improvements...

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW: 8

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 11/30/2017

Comments:
The purpose of this Amendment to the Work Assignment is to replace the Alternate WAM as follows: FROM: David Meisenheimer TO: Toni Jones. Ms. Jones contact information is email: jones.toni@epa.gov, Phone No.: 919-541-0316. All other terms and conditions remain unchanged.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

SFO (*Max 2*) ☐

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

	Cost/Fee	LOE
Contract Period: 04/01/2011 To 11/30/2017		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5041
	FAX Number:	
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5256
	FAX Number:	
Other Agency Official Name (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	
	FAX Number:	
Contracting Official Name: Christopher Davis (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-4609
	FAX Number:	919-685-3415

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000007

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 05/31/2018 Base Option Period Number 4	Revions & Improvements...

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW: 8

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2018

Comments:
This amendment formalizes the direction given by the CO on 11/29/17, via e-mail, to extend the current option period (4), period of performance, for 6 months (ending 05/31/2018). Contractor shall proceed with work assignment, revising cost estimate if needed. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 05/31/2018 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5041 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000008

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 11/30/2018 Base Option Period Number 4	Revisions & Improvements...

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW: 8

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 11/30/2018

Comments:
This amendment lifts the budgetary cap to the approved work plan estimate of $431,079. Additionally, it extends the current option period (4) for 6 months (ending 11/30/2018). Contractor shall proceed with work assignment, revising cost estimate if needed. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

	Cost/Fee:	LOE:
Contract Period: 06/01/2017 To 11/30/2018		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE:
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)		Branch/Mail Code: Phone Number: 919-541-5041 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)		Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)		Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)		Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000009

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 11/30/2018 Base Option Period Number 4	Revisions & Improvements . . .

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW: 8

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 11/30/2018

Comments:
SOW amended (see attachment) to add/update tasks to the SOW. Contractor shall prepare a revised work plan/cost estimate in response to these changes. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
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Authorized Work Assignment Ceiling

Contract Period: 06/01/2017 To 11/30/2018 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5041 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

WAM: Larry Sorrels, OAQPS/HEID/AEG

WAM Phone Number: 919-541-5041

WAM E-mail address: sorrels.larry@epa.gov

Date: 8/7/18

Work Assignment 4-07, Modification 5

Work Assignment Title: Revisions and Improvements to the EPA Air Pollution Control Cost Manual

Statement of Work:

This modification to the work assignment is to revise Sub-Task 7, and to add sub-tasks 9 and 10 to Task 2 of the work assignment. The modification is as follows:

Sub-Task 7: Draft Wet Scrubbers (SO_2) chapter

The language on Sub-Task 7 in this work assignment, including deliverable dates, shall be replaced by the following:

The Contractor shall revise the current draft of the wet scrubbers chapter to account for all edits provided by the WAM, and shall also incorporate updated cost and performance data for scrubbers applied to utility boilers based on information supplied by the WAM. This information reflects updated information on scrubber cost and performance that is found in the latest version (v6) of the Integrated Planning Model (IPM), a version released to the public by EPA on May 31, 2018.

The Contractor shall prepare a revised draft of the chapter that will be suitable for EPA workgroup review. This chapter draft shall then be revised based on comments from the WAM. The chapter shall be titled "Wet and Dry Scrubbers" henceforth. The revised draft shall be submitted to the WAM to meet the deliverable schedule listed below.

Schedule for Sub-Task 7 Deliverables:

Task 7a: Revised draft chapter - 1 ½ months after receipt of WA modification

Task 7b: 2nd revised draft chapter – November 30, 2018

Sub-Task 9: Revisions to SNCR and SCR chapters, and to the SNCR and SCR cost spreadsheets

Under this sub-task, the Contractor shall revise the SNCR and SCR chapters to include updates to the cost and performance data based on information supplied by the WAM. This information reflects updated information on SNCR and SCR cost and performance that is found in the latest version (v6) of the Integrated Planning Model (IPM), a version released to the public by EPA on May 31, 2018. The Contractor shall also update the SNCR and SCR cost spreadsheets to include the updated data.

The Contractor shall prepare a revised draft of each chapter including these updates and other edits from the WAM. The Contractor shall also prepare revised cost spreadsheets that include these updates. These deliverables shall be submitted to the WAM to meet the schedule listed below.

Schedule for Sub-Task 9 Deliverables:

Task 9a: Revised SNCR and SCR chapters - 3 weeks after receipt of WA modification

Task 9b: Revised cost spreadsheets - 1 week after completion of Task 9a

Sub-Task 10: NOx Combustion Controls chapter – Low NOx/Ultra-low NOx Burners

Under this sub-task, the Contractor shall prepare a new control measure chapter for the Control Cost Manual: 1) for low NOx and ultra low NOx. This new chapter shall be prepared using an outline and format that will be provided by the WAM.

The Contractor shall begin by conducting a literature search and an Internet search for information on recent changes in the design, operation, performance and cost of the relevant control equipment. Potential sources of information include trade journal articles, conference proceedings, EPA technical studies, EPA background documentation for rulemaking packages, background documents for RACT, BACT or BART analyses, and control equipment vendor websites. European studies will also be considered as sources of cost data.

The Contractor shall prepare a draft of the chapter consistent with the chapter outline and any additional information from the literature search and guidance from the WAM. This shall include updates to the description of the technology, the capital cost data, and the example calculation for a model facility. Appendices may be provided to present material that is more supplemental to the presented methodology or to address other internal or external issues with the presented data or methodologies. The Contractor shall revise the draft based on comments from the WAM and submit a revised version of the draft chapter back to the WAM. The WAM will distribute this revised version of the chapter to the work group for review.

Schedule for Sub-Task 10 Deliverables:

Task 10a: Draft low NOx and ultra low NOx burners chapter - 2 months after receipt of WA modification

Task 10b: Revised low NOx and ultra low NOx burners chapter – November 30, 2018

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000010

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 05/31/2019 Base X Option Period Number	

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW:

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2019

Comments:
The purpose of this amendment is to extend the period of performance as stated in P00094 of the contract.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

SFO (*Max 2*): ☐

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

Contract Period: 06/01/2017 To 05/31/2019 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code:	
	Phone Number: 919-541-5041	
	FAX Number:	
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code:	
	Phone Number: 919-541-5256	
	FAX Number:	
Other Agency Official Name (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	
	FAX Number:	
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code:	
	Phone Number: 919-541-2147	
	FAX Number:	

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-07

☐ Other ☒ Amendment Number: 000011

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 09/30/2019 Base X Option Period Number	

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW:

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 09/30/2019

Comments:
The purpose of this modification is to extend the period of performance in accordance with P00097. The WA was extended via the modification.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

SFO (*Max 2*) ☐

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

Contract Period: 06/01/2017 To 09/30/2019 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Larry Sorrels (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5041 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☐ Amendment Number:

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016 Base Option Period Number 4	Economic Analysis for Greenhou

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: Sections 1, 3, 4, 6, 7, 8, 11, 15, 16, 17

Purpose:
- [X] Work Assignment
- [ ] Work Assignment Amendment
- [ ] Work Plan Approval
- [ ] Work Assignment Close-Out
- [ ] Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
WA 4-08 Full Title: Economic Analysis for Greenhouse Gas Regulations

This WA continues WA 3-08. See attached SOW. 250 hours are provided for preparation of the work plan and to begin working on the WA.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code (Max 7)
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 03/31/2016 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee: — LOE:

Cumulative Approved: — Cost/Fee: — LOE:

Work Assignment Manager Name: Tom Walton (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5311 FAX Number:
Project Officer Name: Jolynn Collins (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5671 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Rodney-Daryl Jones (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3112 FAX Number:

Statement of Work

I. Title: Economic Analysis for Greenhouse Gas Regulations
Contractor Name: Research Triangle Institute
Contract #: EP-W-11-029
WA #: 4-08

II. Work Assignment Manager (WAM):

Tom Walton
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards (OAQPS)
Health and Environmental Impacts Division, MD-C439-02
Research Triangle Park, NC 27711
919-541-5311 (office)
919-541-0839 (fax)
walton.tom@epa.gov

Alternate WAM:
Alexander Macpherson
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards (OAQPS)
Health and Environmental Impacts Division, MD-C439-02
Research Triangle Park, NC 27711
919-541-5440 (office)
919-541-0839 (fax)
macpherson.alex@epa.gov

III. Background:

The U.S. Environmental Protection Agency (EPA) proposed greenhouse gas (GHG) standards for new electricity generating units (EGUs) in 2013, and emissions standards for existing EGUs and modified sources were proposed in 2014. These standards are expected to be finalized in 2015.

While CGE modeling is not currently anticipated to be included for the final packages for these rules, national-level economic analysis will likely be needed for future climate-related activities and assessments. In past work assignments, the contractor has been updating and refining EMPAX-Dynamic for these potential uses.

The updating and refinement is also expected to inform the development of technical papers for a U.S. EPA Science Advisory Board panel formed to assist EPA in enhancing its capabilities to assess the economy-wide impacts of major regulatory actions. Potential topics to be examined in the technical papers include:

- How best to represent air regulations in a CGE model
- How CGE models compare to detailed sector engineering models
- Incorporating benefits of regulation into a CGE model
- Sources of uncertainty and impacts on CGE results

Future development of the model must meet needs but incorporate learning from the SAB technical paper development as well as the SAB panel guidance expected to be shared in 2016.

Regulatory Impact Analyses have been developed by the contractor for other EGU regulations under previous contracts with EPA. The contractor shall not duplicate work performed under other current or previous contracts.

IV. Description and Tasks:

The WAM is authorized to provide technical direction in accordance with the contract. In accordance with the contract SOW, the Contractor shall perform the following tasks:

Task #1: Prepare Work Plan

The Contractor shall prepare a work plan for this WA in accordance with the contract. The Contractor shall submit this work plan to the WAM within 20 days of the effective date of the WA. The Contractor shall contact the WAM by phone within 5 days of the effective date of the WA to discuss progress on the work plan.

Task #2: Conclude Current EMPAX-Dynamic Update

The Contractor began updating EMPAX-Dynamic under the previous work assignment. The updates included updating the model with 2010 IMPLAN data and 2013 Annual Energy Outlook forecasts. This task shall be completed during this work assignment. Completion includes testing and documenting the current 'cost-only' model using illustrative regulatory scenarios. The model documentation report shall provide details on the model's structure, calibration, closure assumptions, sector and regional detail, approach to taxation, and intertemporal dynamics.

Task #3: Using EMPAX-Dynamic for Assessing Significant Climate Actions

The Contractor shall develop a strategy to employ the EMPAX-Dynamic model to better support economically significant actions including climate-related actions. Examples of such improvements are the development of the capability to assess regulatory actions such as the Clean Power Plan (CPP) proposal for existing EGUs under section 111d of the Clean Air Act. The CPP 111d proposal analysis examined how to reduce CO_2 emission via a combination of "building blocks", including improved efficiency at power plants, re-dispatching toward lower emitting generation, and increasing reliance on renewable energy and demand-side energy efficiency. Incorporating these mitigation

strategies into a CGE framework is challenging. The Contractor shall prepare a technical paper outlining potential methods and the associated advantages and disadvantages of incorporating the building block designs into EMPAX-Dynamic. It expected that this document will contribute to future development of CGE models within U.S. EPA.

Task #4: Develop Options for New CGE Platform

The contractor is establishing a data management platform, ARTEMIS, which in EPA's understanding is a system whereby custom models build from a common data platform. The Contractor shall provide a technical paper outlining how a transition from the current EMPAX-dynamic modeling system to the ARTEMIS system would occur. The paper would outline options for alternative transition paths. A key element of this option development would be an evaluation of whether the ADAGE and EMPAX-Dynamic models would continue to be developed in parallel or whether they would become a single U.S. EPA OAR dynamic CGE model that would potentially meet needs for multiple Offices. Other elements would be to evaluate from a cost and transparency perspective whether to continue reliance on the proprietary IMPLAN datasets and the MPSGE modeling framework.

V. DELIVERABLES:

The Contractor shall meet bi-weekly with EPA for regular updates and adhere to the following schedule:

Task	Deliverable	Due date
1	Work Plan	Within 20 days of the effective date of WA
2	Conclude Current EMPAX-Dynamic Update	No later than July 31, 2015
3	Using EMPAX-Dynamic for Assessing Significant Climate Actions	Upon direction by WAM
4	Develop Options for New CGE Platform	Upon direction by WAM

VI. QA Requirements:

With any analysis provided to EPA, the Contractor shall provide an assessment of the quality and appropriateness of any data used in the analysis. The QA report should discuss the data used with respect to precision, accuracy, representativeness, comparability, completeness, sensitivity, and appropriateness as it applies to this use. If existing QA data is available, the Contractor shall provide the WAM instructions to access it.

VII. Reporting Requirements:

The Contractor shall provide monthly progress reports in accordance with the terms of the contract. The Contractor shall submit work products in electronic as well as hard copy form. In addition, the Contractor shall deliver to the WAM each draft and final report in electronic format that is readable by windows-based word-processing (Microsoft Word 2013), graphics (Microsoft PowerPoint 2013), spreadsheet (Excel 2013), and database (Access 2013) programs. The Contractor shall also provide electronic copies of reports in PDF format. The Contractor shall also provide electronic copies of model files in General Algebraic Modeling System (GAMS) or other appropriate software programs.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000001

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016	Economic Analysis for Greenhou
	Base Option Period Number 4	

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW:

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
WA 4-08 Full Title: Economic Analysis for Greenhouse Gas Regulations

The WAM is hereby changed from Tom Walton to Alex Macpherson. The Alternate WAM is hereby changed from Alex Macpherson to Tom Walton.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code (Max 7)
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 03/31/2016 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee: — LOE:

Cumulative Approved: — Cost/Fee: — LOE:

Work Assignment Manager Name: Alex Macpherson (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-9770 FAX Number:
Project Officer Name: Jolynn Collins (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5671 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Rodney-Daryl Jones (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3112 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000002

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016 Base Option Period Number 4	Economic analysis for Greenhou

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
This WA amended to change the Alternate COR from Tom Walton to Linda Chappell.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 03/31/2016 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Alex Macpherson (Signature) (Date)	Branch/Mail Code:	
	Phone Number: 919-541-9770	
	FAX Number:	
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code:	
	Phone Number: 919-541-5256	
	FAX Number:	
Other Agency Official Name (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	
	FAX Number:	
Contracting Official Name: Mcdonald Morrison (Signature) (Date)	Branch/Mail Code:	
	Phone Number: 919-541-4364	
	FAX Number:	

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000003

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 09/30/2016 Base Option Period Number 4	Economic Analysis for GHG

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 09/30/2016

Comments:
THIS AMENDMENT IS TO EXTEND THE CURRENT OPTION PERIOD (4), PERIOD OF PERFORMANCE, FOR 6 MONTHS (ENDING 9/30/2016). CONTRACTOR SHALL PROCEED WITH WORK ASSIGNMENT, REVISING COST ESTIMATE IF NEEDED. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 09/30/2016 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Alex Macpherson (Signature) (Date)	Branch/Mail Code:	
	Phone Number: 919-541-9770	
	FAX Number:	
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code:	
	Phone Number: 919-541-5256	
	FAX Number:	
Other Agency Official Name (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	
	FAX Number:	
Contracting Official Name: Marsha B. Johnson (Signature) (Date)	Branch/Mail Code:	
	Phone Number: 919-541-0952	
	FAX Number:	

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000004

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 09/30/2016 Base Option Period Number 4	Economic Analysis for GHG

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 09/30/2016

Comments:
See amended Statement of Work (changes highlighted in yellow) to add/revise tasks. Contractor shall prepare a revised work plan/cost estimate in response to these changes. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

	Cost/Fee	LOE
Contract Period: 04/01/2011 To 09/30/2016		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Alex Macpherson	(Signature)	(Date)	Branch/Mail Code: Phone Number: 919-541-9770 FAX Number:
Project Officer Name: Carolyn Blake	(Signature)	(Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name:	(Signature)	(Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Marsha B. Johnson	(Signature)	(Date)	Branch/Mail Code: Phone Number: 919-541-0952 FAX Number:

Statement of Work

I. Title: Economic Analysis for Greenhouse Gas Regulations
Contractor Name: Research Triangle Institute
Contract #: EP-W-11-029
WA #: 4-08

II. Work Assignment Contracting Officer's Representative (WACOR):

Alex Macpherson
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-9770

Alternate WACOR
Linda Chappell
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-2864

III. Background:

In 2016, the U.S. Environmental Protection Agency (EPA) finalized standards for greenhouse gas (GHG) standards for new and modified electricity generating units (EGUs) and emissions standards for existing EGUs. While the standards on existing sources are currently stayed by the courts, economic analysis may be needed going forward. In addition, the EPA is anticipated to finalize GHG standards for new, modified, and reconstruction oil and natural gas emissions sources in 2016 and has committed to developing emissions guidelines for GHGs from existing sources in the sector in the future.

National-level economic analysis may be needed for these future climate-related activities and assessments. In past work assignments, the contractor has been updating and refining EMPAX-Dynamic for these potential uses.

The updating and refinement is also expected to inform the development of technical papers for a U.S. EPA Science Advisory Board panel formed to assist EPA in enhancing

its capabilities to assess the economy-wide impacts of major regulatory actions. Potential topics to be examined in the technical papers include:

- How best to represent air regulations in a CGE model
- How CGE models compare to detailed sector engineering models
- Incorporating benefits of regulation into a CGE model
- Sources of uncertainty and impacts on CGE results

Future development of the model must meet needs but incorporate learning from the SAB technical paper development as well as the SAB panel guidance expected to be shared in 2016.

This Work Assignment is primarily directed at laying the groundwork for developing next generation CGE models that meet the agencies needs for flexibility, transparency, and cost-effectiveness. The work shall build on the Agency's history with the EMPAX modelling framework while draw upon the state of the art from the CGE modelling community.

Regulatory Impact Analyses have been developed by the contractor for other EGU regulations under previous contracts with EPA. The contractor shall not duplicate work performed under other current or previous contracts.

IV. Description and Tasks:

The WAM is authorized to provide technical direction in accordance with the contract. In accordance with the contract SOW, the Contractor shall perform the following tasks:

Task #1: Prepare Work Plan

The Contractor shall prepare a work plan for this WA in accordance with the contract. The Contractor shall submit this work plan to the WAM within 20 days of the effective date of the WA. The Contractor shall contact the WAM by phone within 5 days of the effective date of the WA to discuss progress on the work plan.

Task #2: Conclude Current EMPAX-Dynamic Update

The Contractor began updating EMPAX-Dynamic under the previous work assignment. The updates included updating the model with 2010 IMPLAN data and 2013 Annual Energy Outlook forecasts. This task shall be completed during this work assignment. Completion includes testing and documenting the current 'cost-only' model using illustrative regulatory scenarios. The model documentation report shall provide details on the model's structure, calibration, closure assumptions, sector and regional detail, approach to taxation, and intertemporal dynamics.

Task #3: Using EMPAX-Dynamic for Assessing Significant Climate Actions

The Contractor shall develop a strategy to employ the EMPAX-Dynamic model to better support economically significant actions including climate-related actions. Examples of such improvements are the development of the capability to assess regulatory actions such as the Clean Power Plan (CPP) proposal for existing EGUs under section 111d of the Clean Air Act. The CPP 111d proposal analysis examined how to reduce CO_2 emission via a combination of "building blocks", including improved efficiency at power plants, re-dispatching toward lower emitting generation, and increasing reliance on renewable energy and demand-side energy efficiency. Incorporating these mitigation strategies into a CGE framework is challenging. The Contractor shall prepare a technical paper outlining potential methods and the associated advantages and disadvantages of incorporating the building block designs into EMPAX-Dynamic. It expected that this document will contribute to future development of CGE models within U.S. EPA.

Task #4: Develop and Document New CGE Platform

Task #4a: Develop data platform (baseline setting and calibration)

The contractor is establishing a data platform, ARTEMIS, which is a system whereby custom models build from a common data platform. Consistent with this system, the Contractor shall develop a baseline dataset for a CGE model calibrated to external forecasts, including the Annual Energy Outlook. The time series of social accounting matrices shall contribute to both static and dynamic CGE models to be developed in future.

Task #4b: Develop supporting technical document

The contractor shall develop a technical paper presenting the methodology and associated data analysis and the advantages and disadvantages of the approach relative to alternative approaches. The paper would outline options for alternative transition paths.

Task #5: Case Study: Linking Partial and General Equilibrium Models

A partial equilibrium model with a high degree of engineering detail can provide detailed information about how regulation might affect the sector modeled. If the regulated sector is highly connected to other sectors of the economy, a partial equilibrium model likely offers little insight about the general equilibrium impacts of the regulation. If regulatory impacts on the sector might have general equilibrium impacts, it may be beneficial to link the partial equilibrium model to a computable general equilibrium (CGE) model to capture effects both within and outside of the regulated sector. However, there are many possible approaches to link models, each approach having advantages and disadvantages.

Task #5a: Conduct Literature Review

The contractor shall first review the "linking models" literature cited in the U.S. EPA's "Economy Wide Modeling: Social Cost and Welfare White Paper"[1] and other papers, as appropriate, to understand current literature on the topic.

Task #5b: Alternative Approaches to Linking Models

The contractor shall develop and implement alternative approaches to linking a partial equilibrium model with a high degree of engineering detail with a CGE model, using off-the-shelf models

The partial equilibrium model to be used is the Industrial Sector Integrated Solutions Cement model developed to support recent regulatory actions in the cement sector. The WACOR will provide the Cement model code and data, as well as guidance on model concepts, coding, and usage, as appropriate. The use of the cement model is for case study purposes only. It is currently not anticipated that a cement and CGE linked models would be needed for a regulatory application.

The CGE model used for this task will be the current version of the EMPAX CGE model. Whether the static or dynamic version of EMPAX is used will be determined in consultation with the WACOR.

The contractor shall develop at least three alternative approaches to link the models. These approaches shall be described in writing, and be provided to the WACOR. The WACOR will provide review and technical direction prior to the approaches being implemented in GAMS. Once approaches are reviewed by the WACOR the contractor shall implement in GAMS the three alternative approaches. Provided below are (in order of increasing complexity or "connectivity"), the three general approaches for the contractor to follow:

- Soft linking – Extract information from cement model and insert into EMPAX, possibly iteratively, but with manual information feedback (perhaps similar to previous IPM-EMPAX linkages).

- Summary function approach – Summarize key economic information from the Cement model in the form of an aggregated functional relationship and embed in EMPAX.

- Sequential calibration – Introduce a constant elasticity supply function in EMPAX, and run the Cement and CGE models in sequence, successively calibrating supply function until equilibrium price and quantities converge between models.

Task #5c: Prepare Report on Model Linkages Exercise

[1]https://yosemite.epa.gov/sab/sabproduct.nsf//LookupWebProjectsCurrentBOARD/07E67CF77B54734285257BB0004F87ED/$File/Social+Cost+and+Welfare+White+Paper+9-22-15.pdf

In accordance with the contract SOW and after receiving technical direction, the Contractor shall prepare a report. The report shall include a synthesis of the literature, technical descriptions of the alternative approaches implemented, and a summary section that compares and contrasts the alternative approaches.

V. DELIVERABLES:

The Contractor shall meet bi-weekly with EPA for regular updates and adhere to the following schedule:

Task	Deliverable	Due date
1	Work Plan	Within 20 days of the effective date of WA
2	Conclude Current EMPAX-Dynamic Update	No later than July 31, 2015
3	Using EMPAX-Dynamic for Assessing Significant Climate Actions	Upon direction by WAM
4a	Develop data platform (baseline setting and calibration)	Upon direction by WACOR
4b	Develop supporting technical document	Upon direction by WACOR
5a	Presentation of Literature Review with EPA WAM and other EPA economists	Within 4 weeks of receiving technical direction
5b	Presentation of Alternative Approaches, Results, and Discussion with EPA WACOR and other EPA economists	Within 12 weeks of receiving technical direction
5c	Completed Report	Within 12 weeks of receiving technical direction or in consultation with the EPA WACOR

VI. QA Requirements:

With any analysis provided to EPA, the Contractor shall provide an assessment of the quality and appropriateness of any data used in the analysis. The QA report should discuss the data used with respect to precision, accuracy, representativeness, comparability, completeness, sensitivity, and appropriateness as it applies to this use. If existing QA data is available, the Contractor shall provide the WACOR instructions to access it.

VII. Reporting Requirements:

The Contractor shall provide monthly progress reports in accordance with the terms of the contract. The Contractor shall submit work products in electronic as well as hard copy form. In addition, the Contractor shall deliver to the WACOR each draft and final report in electronic format that is readable by windows-based word-processing (Microsoft Word 2013), graphics (Microsoft PowerPoint 2013), spreadsheet (Excel 2013), and database (Access 2013) programs. The Contractor shall also provide electronic copies of reports in PDF format. The Contractor shall also provide electronic copies of model files in General Algebraic Modeling System (GAMS) or other appropriate software programs.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000005

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 05/31/2017 Base Option Period Number 4	Economic Analysis for GHG

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2017

Comments:
THIS AMENDMENT IS TO (1) EXTEND THE CURRENT OPTION PERIOD FOR 8 MONTHS (ENDING 5/31/2017), (2) CHANGE CO TO ANDREW FLYNN, AND (3) CHANGE WAM AND ALT WAM. CONTRACTOR SHALL PROCEED WITH WORK ASSIGNMENT, REVISING COST ESTIMATE IF NEEDED. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
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Authorized Work Assignment Ceiling

	Cost/Fee	LOE
Contract Period: 04/01/2011 To 05/31/2017		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Jenny Thomas (Signature) (Date)	Branch/Mail Code: Phone Number: 202-564-4524 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Andrew Flynn (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2674 FAX Number: 919-541-0611

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000006

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 05/31/2017 Base Option Period Number 4	Economic Analysis for GHG

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2017

Comments:
THIS AMENDMENT IS TO (1) LIFT CAP TO FULL AMOUNT OF $238,402.00, (2) REVISE SOW (SEE HIGHLIGHTED CHANGES);(3) CHANGE CO TO CHRISTOPHER DAVIS. CONTRACTOR SHALL PROVIDE REVISED WORK PLAN IN RESPONSE TO AMENDED SOW. NO PREVIOUSLY PERFORMED WORK SHALL BE DUPLICATED.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
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Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 05/31/2017 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Jenny Thomas (Signature) (Date)	Branch/Mail Code: Phone Number: 202-564-4524 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christopher Davis (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-4609 FAX Number: 919-685-3415

Statement of Work – Amendment 6

I. Title: Economic Analysis for Greenhouse Gas Regulations
Contractor Name: Research Triangle Institute
Contract #: EP-W-11-029
WA #: 4-08

II. Work Assignment Manager (WAM):

Jenny Thomas
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-0306

Alternate WAM
Alex Macpherson
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-9770

III. Background:

In 2016, the U.S. Environmental Protection Agency (EPA) finalized standards for greenhouse gas (GHG) standards for new and modified electricity generating units (EGUs) and emissions standards for existing EGUs. While the standards on existing sources are currently stayed by the courts, economic analysis may be needed going forward. In addition, the EPA is anticipated to finalize GHG standards for new, modified, and reconstruction oil and natural gas emissions sources in 2016 and has committed to developing emissions guidelines for GHGs from existing sources in the sector in the future.

National-level economic analysis may be needed for these future climate-related activities and assessments. In past work assignments, the contractor has been updating and refining EMPAX-Dynamic for these potential uses.

The updating and refinement is also expected to inform the development of technical papers for a U.S. EPA Science Advisory Board panel formed to assist EPA in enhancing

its capabilities to assess the economy-wide impacts of major regulatory actions. Potential topics to be examined in the technical papers include:

- How best to represent air regulations in a CGE model
- How CGE models compare to detailed sector engineering models
- Incorporating benefits of regulation into a CGE model
- Sources of uncertainty and impacts on CGE results

Future development of the model must meet needs but incorporate learning from the SAB technical paper development as well as the SAB panel guidance expected to be shared in 2016.

This Work Assignment is primarily directed at laying the groundwork for developing next generation CGE models that meet the agencies needs for flexibility, transparency, and cost-effectiveness. The work shall build on the Agency's history with the EMPAX modelling framework while draw upon the state of the art from the CGE modelling community.

Regulatory Impact Analyses have been developed by the contractor for other EGU regulations under previous contracts with EPA. The contractor shall not duplicate work performed under other current or previous contracts.

IV. Description and Tasks:

The WAM is authorized to provide technical direction in accordance with the contract. In accordance with the contract SOW, the Contractor shall perform the following tasks:

Task #1: Prepare Work Plan

The Contractor shall prepare a work plan for this WA in accordance with the contract. For this amendment, the work plan should address the increase amount only. The Contractor shall submit this work plan to the WAM within 20 days of the effective date of the WA. The Contractor shall contact the WAM by phone within 5 days of the effective date of the WA to discuss progress on the work plan.

Task #2: Conclude Current EMPAX-Dynamic Update

No changes to this task.

Task #3: Using EMPAX-Dynamic for Assessing Significant Climate Actions

No changes to this task.

Task #4: Develop and Document New CGE Platform

Task #4a: Develop data platform (baseline setting and calibration)

No changes to this task.

Task #4b: Develop supporting technical document

No changes to this task.

Task #4c: Regionalization of social accounting matrices

Building on the work done under task 4a to establish a national baseline dataset calibrated to external forecasts, the contractor shall develop a baseline dataset for a CGE model using a flexible methodology that allows for alternative regional structures. This methodology should be directly incorporated into the baseline setting and calibration process already under development (task 4a). This baseline dataset will consist of a time series of social accounting matrices with regional detail calibrated to external forecasts, including the Annual Energy Outlook. The exact number of regions for a prototype model version will be determined in coordination with the EPA WAM. For estimating purposes, the contractor may assume dividing the working national-level dataset developed under task 4a into nine Census Divisions.

Task #4d:

In coordination with task 4c, the contractor shall explore the sensitivities of the calibration procedure used to develop the set of balanced social accounting matrices in tasks 4a and 4c to important modeling considerations. The contractor shall explore how the calibration procedure reacts varying important model dimensions – e.g. time, sectoral, geographic, and household dimensions. The specific design of tests of the calibration procedure shall be decided upon in coordination with the EPA WAM and documented via technical direction prior to the initiation of testing.

In designing and conducting these tests, the contractor shall be mindful that the ultimate goal of this work is to understand the tradeoffs in the calibration process to allow for the development of a flexible calibration procedure that can allow for changing resolutions of the model as needed for a specific application. For example, one application may require greater sectoral detail, while a different application may require more geographic detail. The contractor shall document the findings of this testing of the calibration along with any recommendations in a report to the EPA WAM.

Task #5: Case Study: Linking Partial and General Equilibrium Models

No changes to this task or subtasks.

V. DELIVERABLES:

The Contractor shall meet bi-weekly with EPA for regular updates and adhere to the following schedule:

Task	Deliverable	Due date
1	Work Plan	Within 20 days of the effective date of WA
2	Conclude Current EMPAX-Dynamic Update	No later than July 31, 2015
3	Using EMPAX-Dynamic for Assessing Significant Climate Actions	Upon direction by WAM
4a	Develop data platform (baseline setting and calibration)	Upon direction by WAM
4b	Develop supporting technical document	Upon direction by WAM
4c	Develop regionalized baseline dataset	Upon direction from EPA WAM.
4d	Test calibration procedure and document results in a report to EPA WAM.	Upon direction from EPA WAM.
5a	Presentation of Literature Review with EPA WAM and other EPA economists	Within 4 weeks of receiving technical direction
5b	Presentation of Alternative Approaches, Results, and Discussion with EPA WAM and other EPA economists	Within 12 weeks of receiving technical direction
5c	Completed Report	Within 12 weeks of receiving technical direction or in consultation with the EPA WAM

VI. QA Requirements:

With any analysis provided to EPA, the Contractor shall provide an assessment of the quality and appropriateness of any data used in the analysis. The QA report should discuss the data used with respect to precision, accuracy, representativeness, comparability, completeness, sensitivity, and appropriateness as it applies to this use. If existing QA data is available, the Contractor shall provide the WAM instructions to access it.

VII. Reporting Requirements:

The Contractor shall provide monthly progress reports in accordance with the terms of the contract. The Contractor shall submit work products in electronic as well as hard copy form. In addition, the Contractor shall deliver to the WAM each draft and final report in electronic format that is readable by windows-based word-processing (Microsoft Word 2013), graphics (Microsoft PowerPoint 2013), spreadsheet (Excel 2013), and database (Access 2013) programs. The Contractor shall also provide electronic copies of reports in PDF format. The Contractor shall also provide electronic copies of model files in General Algebraic Modeling System (GAMS) or other appropriate software programs.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000007

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 11/30/2017 Base Option Period Number 4	Economic-Wide Modeling Supp

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 11/30/2017

Comments:
This Amendment extends the current option period (4) for 6 months (ending 11/30/2017). SOW is changed (Tasks 2,3 removed, Task 6 added). The contractor is requested to provide a revised Work Plan/Cost Estimate. No previous work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 11/30/2017 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Jenny Thomas (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	202-564-4524
	FAX Number:	
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5256
	FAX Number:	
Other Agency Official Name (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	
	FAX Number:	
Contracting Official Name: Christopher Davis (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-4609
	FAX Number:	919-685-3415

Statement of Work

I. **Title:** Economy-Wide Modeling Support
Contractor Name: Research Triangle Institute
Contract #: EP-W-11-029
WA #: 4-08

II. **Work Assignment Manager (WAM):**

Jenny Thomas
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-0306

Alternate WAM
Alex Macpherson
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-9770

III. **Background:**

Through this work assignment the contractor will support the U.S. EPA in developing its economy-wide modeling capabilities. The contractor will assist the U.S. EPA in development of a new Computable General Equilibrium (CGE) models, development of technical papers, and in applications of CGE Models.

The U.S. EPA Science Advisory Board panel on Economy-wide Modeling of the Benefits and Costs of Environmental Regulation is expected to submit a final report to the Agency in 2017. The contractor may assist in U.S. EPA in the development of technical papers surrounding the panel's recommendations as well as incorporating the panel's recommendations in the next generation of CGE models.

The contractor will also work with the Agency to lay the groundwork for developing next generation CGE models that meet the Agency's needs for flexibility, transparency, and cost-effectiveness. The work shall build on the Agency's history with the EMPAX

modelling framework while also drawing upon the current state of the science in the CGE modelling community.

The contractor shall not duplicate work performed under other current or previous contracts.

IV. Description and Tasks:

The WAM is authorized to provide technical direction in accordance with the contract. In accordance with the contract SOW, the contractor shall perform the following tasks:

Task #1: Prepare Work Plan

The contractor shall prepare a work plan for this WA in accordance with the contract. For this amendment, the work plan should address the increase amount only. The contractor shall submit this work plan to the WAM within 20 days of the effective date of the WA. The contractor shall contact the WAM by phone within 5 days of the effective date of the WA to discuss progress on the work plan.

Task #4: Develop and Document New CGE Platform

Commented [TJ1]: This task is complete and is no longer needed.

Commented [TJ2]: This task is no longer needed.

Task #4a: Develop data platform (baseline setting and calibration)

The contractor shall develop a baseline dataset for a CGE model calibrated to external forecasts, including the Annual Energy Outlook. The time series of social accounting matrices shall contribute to both static and dynamic CGE models to be developed in future.

Task #4b: Develop supporting technical document

The contractor shall develop a technical paper presenting the methodology and associated data analysis and the advantages and disadvantages of the approach relative to alternative approaches. The paper would outline options for alternative transition paths.

Task #4c: Regionalization of social accounting matrices

Building on the work done under task 4a to establish a national baseline dataset calibrated to external forecasts, the contractor shall develop a baseline dataset for a CGE model using a flexible methodology that allows for alternative regional structures. This

methodology should be directly incorporated into the baseline setting and calibration process already under development (task 4a). This baseline dataset will consist of a time series of social accounting matrices with regional detail calibrated to external forecasts, including the Annual Energy Outlook. The exact number of regions for a prototype model version will be determined in coordination with the EPA WAM. For estimating purposes, the contractor may assume dividing the working national-level dataset developed under task 4a into nine Census Divisions.

Task #4d: Sensitivity testing

In coordination with task 4c, the contractor shall explore the sensitivities of the calibration procedure used to develop the set of balanced social accounting matrices in tasks 4a and 4c to important modeling considerations. The contractor shall explore how the calibration procedure reacts varying important model dimensions – e.g. time, sectoral, geographic, and household dimensions. The specific design of tests of the calibration procedure shall be decided upon in coordination with the EPA WAM and documented via technical direction prior to the initiation of testing.

In designing and conducting these tests, the contractor shall be mindful that the ultimate goal of this work is to understand the tradeoffs in the calibration process to allow for the development of a flexible calibration procedure that can allow for changing resolutions of the model as needed for a specific application. For example, one application may require greater sectoral detail, while a different application may require more geographic detail. The contractor shall document the findings of this testing of the calibration along with any recommendations in a report to the EPA WAM.

Task #4e: Parameterization and Documentation

Continuing the development of a new CGE platform, the contractor shall work with the U.S. EPA to parameterize the mathematical equations used in the new CGE model. The model equations will be used in static and dynamic CGE models. This work will be initiated at the request of the EPA WAM via technical direction. The choice of functional forms and parameters shall be developed in coordination with the U.S. EPA and based on relevant literature. Sensitivity testing of the selected parameters may also be requested by the EPA WAM via technical direction.

The contractor shall document the selected functional forms and parameters in supporting technical documentation submitted to the EPA WAM.

Task #5: Case Study: Linking Partial and General Equilibrium Models

A partial equilibrium model with a high degree of engineering detail can provide detailed information about how regulation might affect the sector modeled. If the regulated sector is highly connected to other sectors of the economy, a partial equilibrium model likely offers little insight about the general equilibrium impacts of the regulation. If regulatory

impacts on the sector might have general equilibrium impacts, it may be beneficial to link the partial equilibrium model to a computable general equilibrium (CGE) model to capture effects both within and outside of the regulated sector. However, there are many possible approaches to link models, each approach having advantages and disadvantages.

Task #5a: Conduct Literature Review

The contractor shall first review the "linking models" literature cited in the U.S. EPA's "Economy Wide Modeling: Social Cost and Welfare White Paper"[1] and other papers, as appropriate, to understand current literature on the topic.

Task #5b: Alternative Approaches to Linking Models

The contractor shall develop and implement alternative approaches to linking a partial equilibrium model with a high degree of engineering detail with a CGE model, using off-the-shelf models

The partial equilibrium model to be used is the Industrial Sector Integrated Solutions Cement model developed to support recent regulatory actions in the cement sector. The WAM will provide the Cement model code and data, as well as guidance on model concepts, coding, and usage, as appropriate. The use of the cement model is for case study purposes only. It is currently not anticipated that a cement and CGE linked models would be needed for a regulatory application.

The CGE model used for this task will be the current version of the EMPAX CGE model. Whether the static or dynamic version of EMPAX is used will be determined in consultation with the WAM.

The contractor shall develop at least three alternative approaches to link the models. These approaches will be described in writing, and be provided to the WAM. The WAM will provide review and technical direction prior to the approaches being implemented in GAMS. Once approaches are reviewed by the WAM the contractor shall implement in GAMS the three alternative approaches. Provided below are (in order of increasing complexity or "connectivity"), the three general approaches for the contractor to follow:

- Soft linking – Extract information from cement model and insert into EMPAX, possibly iteratively, but with manual information feedback (perhaps similar to previous IPM-EMPAX linkages).

- Summary function approach – Summarize key economic information from the Cement model in the form of an aggregated functional relationship and embed in EMPAX.

[1]https://yosemite.epa.gov/sab/sabproduct.nsf//LookupWebProjectsCurrentBOARD/07E67CF77B54734285257BB0004F87ED/$File/Social+Cost+and+Welfare+White+Paper+9-22-15.pdf

- Sequential calibration – Introduce a constant elasticity supply function in EMPAX, and run the Cement and CGE models in sequence, successively calibrating supply function until equilibrium price and quantities converge between models.

Task #5c: Prepare Report on Model Linkages Exercise

In accordance with the contract SOW and after receiving technical direction, the Contractor shall prepare a report. The report shall include a synthesis of the literature, technical descriptions of the alternative approaches implemented, and a summary section that compares and contrasts the alternative approaches.

Task #6: Technical Assistance on Recommendations from Science Advisory Board Panel Report

Commented [TJ3]: Q for contracts - I am unsure if it is best to just retire task #s 2 and 3 and have this as task 6, or to renumber the tasks. Either way is fine.

The U.S. EPA Science Advisory Board panel on Economy-wide Modeling of the Benefits and Costs of Environmental Regulation is expected to submit a final report to the Agency in 2017. The contractor may assist in U.S. EPA in the development of technical papers surrounding the panel's recommendations as well as incorporating the panel's recommendations in the next generation of CGE models.

Technical papers may be requested on the incorporation of unemployment in CGE models and measurement of benefits in CGE models, among other topics. Technical papers will be requested by the EPA WAM via technical direction. In preparing technical papers the contractor shall review the discussion in the SAB panel report (once complete), literature cited in the panel report, as well as other relevant literature. The technical paper shall include a synthesis of the literature, technical descriptions of the alternative approaches implemented, and a summary section that compares and contrasts the alternative approaches.

Any insights from the SAB panel report shall also inform the CGE model development under Task 4.

V. DELIVERABLES:

The Contractor shall meet bi-weekly with EPA for regular updates and adhere to the following schedule:

Task	Deliverable	Due date

1	Work Plan	Within 20 days of the effective date of WA
2		
3		
4a	Develop data platform (baseline setting and calibration)	Upon direction by WAM
4b	Develop supporting technical document	Upon direction by WAM
4c	Develop regionalized baseline dataset	Upon direction from EPA WAM.
4d	Test calibration procedure and document results in a report to EPA WAM.	Upon direction from EPA WAM.
4e	Parameterize mathematical equations and complete technical documentation.	Upon direction from EPA WAM
5a	Presentation of Literature Review with EPA WAM and other EPA economists	Within 4 weeks of receiving technical direction
5b	Presentation of Alternative Approaches, Results, and Discussion with EPA WAM and other EPA economists	Within 12 weeks of receiving technical direction
5c	Completed Report	Within 12 weeks of receiving technical direction or in consultation with the EPA WAM
6	Technical papers on recommendations from SAB panel report	Upon direction from EPA WAM

VI. QA Requirements:

With any analysis provided to EPA, the Contractor shall provide an assessment of the quality and appropriateness of any data used in the analysis. The QA report should discuss the data used with respect to precision, accuracy, representativeness, comparability, completeness, sensitivity, and appropriateness as it applies to this use. If existing QA data is available, the Contractor shall provide the WAM instructions to access it.

VII. Reporting Requirements:

The Contractor shall provide monthly progress reports in accordance with the terms of the contract. The Contractor shall submit work products in electronic as well as hard copy

form. In addition, the Contractor shall deliver to the WAM each draft and final report in electronic format that is readable by windows-based word-processing (Microsoft Word 2013), graphics (Microsoft PowerPoint 2013), spreadsheet (Excel 2013), and database (Access 2013) programs. The Contractor shall also provide electronic copies of reports in PDF format. The Contractor shall also provide electronic copies of model files in General Algebraic Modeling System (GAMS) or other appropriate software programs.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000008

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 11/30/2017	Economic-Wide Modeling Support
	Base Option Period Number 4	

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 11/30/2017

Comments:
The Statement of Work (SOW) for this Work Assignment is amended. The changes are highlighted in the attached SOW. The contractor shall provide a revised work plan and cost estimate for these changes. No previously performed EPA work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 11/30/2017 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Jenny Thomas (Signature) (Date)	Branch/Mail Code: Phone Number: 202-564-4524 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christopher Davis (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-4609 FAX Number: 919-685-3415

Statement of Work – Amendment 8

I. Title: Economy-Wide Modeling Support
Contractor Name: Research Triangle Institute
Contract #: EP-W-11-029
WA #: 4-08

II. Work Assignment Manager (WAM):

Jenny Thomas
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-0306

Alternate WAM
Alex Macpherson
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-9770

III. Background:

Through this work assignment the contractor will support the U.S. EPA in developing its economy-wide modeling capabilities. The contractor will assist the U.S. EPA in development of a new Computable General Equilibrium (CGE) models, development of technical papers, and in applications of CGE Models.

The U.S. EPA Science Advisory Board panel on Economy-wide Modeling of the Benefits and Costs of Environmental Regulation is expected to submit a final report to the Agency in 2017. The contractor may assist in U.S. EPA in the development of technical papers surrounding the panel's recommendations as well as incorporating the panel's recommendations in the next generation of CGE models.

The contractor will also work with the Agency to lay the groundwork for developing next generation CGE models that meet the Agency's needs for flexibility, transparency, and cost-effectiveness. The work shall build on the Agency's history with the EMPAX

modelling framework while also drawing upon the current state of the science in the CGE modelling community.

The contractor shall not duplicate work performed under other current or previous contracts.

IV. Description and Tasks:

The WAM is authorized to provide technical direction in accordance with the contract. In accordance with the contract SOW, the contractor shall perform the following tasks:

Task #1: Prepare Work Plan

The contractor shall prepare a work plan for this WA in accordance with the contract. For this amendment, the work plan should address the increase amount only. The contractor shall submit this work plan to the WAM within 20 days of the effective date of the WA. The contractor shall contact the WAM by phone within 5 days of the effective date of the WA to discuss progress on the work plan.

Tasks #2 and #3 are complete and were removed in previous amendment.

Task #4: Develop and Document New CGE Platform

Task #4a: Develop data platform (baseline setting and calibration)

The contractor shall develop a baseline dataset for a CGE model calibrated to external forecasts, including the Annual Energy Outlook. The time series of social accounting matrices shall contribute to both static and dynamic CGE models to be developed in future.

Task #4b: Develop supporting technical document

The contractor shall develop a technical paper presenting the methodology and associated data analysis and the advantages and disadvantages of the approach relative to alternative approaches. The paper would outline options for alternative transition paths.

Task #4c: Regionalization of social accounting matrices

Building on the work done under task 4a to establish a national baseline dataset calibrated to external forecasts, the contractor shall develop a baseline dataset for a CGE model using a flexible methodology that allows for alternative regional structures. This methodology should be directly incorporated into the baseline setting and calibration process already under development (task 4a). This baseline dataset will consist of a time series of social accounting matrices with regional detail calibrated to external forecasts, including the Annual Energy Outlook. The exact number of regions for a prototype model version will be determined in coordination with the EPA WAM. For estimating

purposes, the contractor may assume dividing the working national-level dataset developed under task 4a into nine Census Divisions.

Task #4d: Sensitivity testing

In coordination with task 4c, the contractor shall explore the sensitivities of the calibration procedure used to develop the set of balanced social accounting matrices in tasks 4a and 4c to important modeling considerations. The contractor shall explore how the calibration procedure reacts varying important model dimensions – e.g. time, sectoral, geographic, and household dimensions. The specific design of tests of the calibration procedure shall be decided upon in coordination with the EPA WAM and documented via technical direction prior to the initiation of testing.

In designing and conducting these tests, the contractor shall be mindful that the ultimate goal of this work is to understand the tradeoffs in the calibration process to allow for the development of a flexible calibration procedure that can allow for changing resolutions of the model as needed for a specific application. For example, one application may require greater sectoral detail, while a different application may require more geographic detail. The contractor shall document the findings of this testing of the calibration along with any recommendations in a report to the EPA WAM.

Task #4e: Parameterization and Documentation

Continuing the development of a new CGE platform, the contractor shall work with the U.S. EPA to parameterize the mathematical equations used in the new CGE model. The model equations will be used in static and dynamic CGE models. This work will be initiated at the request of the EPA WAM via technical direction. The choice of functional forms and parameters shall be developed in coordination with the U.S. EPA and based on relevant literature. Sensitivity testing of the selected parameters may also be requested by the EPA WAM via technical direction.

The contractor shall document the selected functional forms and parameters in supporting technical documentation submitted to the EPA WAM.

Task #4f: Develop Baseline Dataset using Publicly-Available Data

While the CGE models are often necessarily built using datasets requiring a license (e.g. IMPLAN data), as part of ongoing efforts to construct a dynamic CGE model that uses exclusively open-source data, as part of this task the contractor will work with the EPA WAM in exploring the use of Bureau of Economic Analysis Benchmark Input-Output Accounts data[1] to construct a social accounting matrix. The contractor shall present to the EPA WAM other open source datasets for consideration under this task. The contractor shall work with the EPA WAM to develop code processing the BEA data into a form for processing by the baseline setting and calibration and regionalization

[1] https://www.bea.gov/industry/index.htm#benchmark_io

procedure developed under tasks 4a and 4c. The contractor shall work with the EPA WAM to resolve any challenges encountered in (1) manipulating the data for use in the baseline setting process and (2) any challenges encountered in processing this data using the baseline-setting code.

Task #4g: Disaggregation of the Power Sector in the CGE Model

Given the importance of the power sector, there is often interest in a detailed understanding of the impacts of a regulation on this sector. In order to assist in such an analysis, the contractor shall disaggregate the power sector in the CGE model developed throughout task 4. The contractor shall draw upon data and experience from the development of the publication *Construction and application of the MEEDE dataset*[2] in completing this task. The contractor shall document the process used to accomplish this disaggregation and share with the EPA WAM code developed as part of this work. The contractor shall also edit the code for baseline setting and calibration and regionalization developed under tasks 4a and 4c to be compatible with a disaggregated power sector. Code produced as part of this effort shall be considered open source.

Task #5: Case Study: Linking Partial and General Equilibrium Models

A partial equilibrium model with a high degree of engineering detail can provide detailed information about how regulation might affect the sector modeled. If the regulated sector is highly connected to other sectors of the economy, a partial equilibrium model likely offers little insight about the general equilibrium impacts of the regulation. If regulatory impacts on the sector might have general equilibrium impacts, it may be beneficial to link the partial equilibrium model to a computable general equilibrium (CGE) model to capture effects both within and outside of the regulated sector. However, there are many possible approaches to link models, each approach having advantages and disadvantages.

Task #5a: Conduct Literature Review

The contractor shall first review the "linking models" literature cited in the U.S. EPA's "Economy Wide Modeling: Social Cost and Welfare White Paper"[3] and other papers, as appropriate, to understand current literature on the topic.

Task #5b: Alternative Approaches to Linking Models

The contractor shall develop and implement alternative approaches to linking a partial equilibrium model with a high degree of engineering detail with a CGE model, using off-the-shelf models

The partial equilibrium model to be used is the Industrial Sector Integrated Solutions Cement model developed to support recent regulatory actions in the cement sector. The

[2] https://www.rti.org/rti-press-publication/construction-and-application-meede-dataset

[3]https://yosemite.epa.gov/sab/sabproduct.nsf//LookupWebProjectsCurrentBOARD/07E67CF77B54734285257BB0004F87ED/$File/Social+Cost+and+Welfare+White+Paper+9-22-15.pdf

WAM will provide the Cement model code and data, as well as guidance on model concepts, coding, and usage, as appropriate. The use of the cement model is for case study purposes only. It is currently not anticipated that a cement and CGE linked models would be needed for a regulatory application.

The CGE model used for this task will be the current version of the EMPAX CGE model. Whether the static or dynamic version of EMPAX is used will be determined in consultation with the WAM.

The contractor shall develop at least three alternative approaches to link the models. These approaches will be described in writing, and be provided to the WAM. The WAM will provide review and technical direction prior to the approaches being implemented in GAMS. Once approaches are reviewed by the WAM the contractor shall implement in GAMS the three alternative approaches. Provided below are (in order of increasing complexity or "connectivity"), the three general approaches for the contractor to follow:

- Soft linking – Extract information from cement model and insert into EMPAX, possibly iteratively, but with manual information feedback (perhaps similar to previous IPM-EMPAX linkages).

- Summary function approach – Summarize key economic information from the Cement model in the form of an aggregated functional relationship and embed in EMPAX.

- Sequential calibration – Introduce a constant elasticity supply function in EMPAX, and run the Cement and CGE models in sequence, successively calibrating supply function until equilibrium price and quantities converge between models.

Task #5c: Prepare Report on Model Linkages Exercise

In accordance with the contract SOW and after receiving technical direction, the Contractor shall prepare a report. The report shall include a synthesis of the literature, technical descriptions of the alternative approaches implemented, and a summary section that compares and contrasts the alternative approaches.

Task #6: Technical Assistance on Recommendations from Science Advisory Board Panel Report

The U.S. EPA Science Advisory Board panel on Economy-wide Modeling of the Benefits and Costs of Environmental Regulation is expected to submit a final report to the Agency in 2017. The contractor may assist in U.S. EPA in the development of technical papers surrounding the panel's recommendations as well as incorporating the panel's recommendations in the next generation of CGE models.

Technical papers may be requested on the incorporation of unemployment in CGE models and measurement of benefits in CGE models, among other topics. Technical papers will be requested by the EPA WAM via technical direction. In preparing technical papers the contractor shall review the discussion in the SAB panel report (once complete), literature cited in the panel report, as well as other relevant literature. The technical paper shall include a synthesis of the literature, technical descriptions of the alternative approaches implemented, and a summary section that compares and contrasts the alternative approaches.

Any insights from the SAB panel report shall also inform the CGE model development under Task 4.

In order to assist the EPA WAM in participating in Agency efforts regarding CGE modeling the contractor may also be asked to develop CGE model code, code to process data, and share that code with the EPA WAM and other EPA staff via online code repositories (e.g. GitHub). Any code developed as part of this task will be considered open source. Deliverables will be requested via technical direction from the EPA WAM.

V. DELIVERABLES:

The Contractor shall meet bi-weekly with EPA for regular updates and adhere to the following schedule:

Task	Deliverable	Due date
1	Work Plan	Within 20 days of the effective date of WA
2	*Tasks 2 and 3 are complete.*	
3		
4a	Develop data platform (baseline setting and calibration)	Upon direction by WAM
4b	Develop supporting technical document	Upon direction by WAM
4c	Develop regionalized baseline dataset	Upon direction from EPA WAM.

4d	Test calibration procedure and document results in a report to EPA WAM.	Upon direction from EPA WAM.
4e	Parameterize mathematical equations and complete technical documentation.	Upon direction from EPA WAM
4f	Develop baseline dataset using publicly-available data	Upon direction from EPA WAM
4g	Disaggregate energy sector in CGE	Upon direction from EPA WAM
5a	Presentation of Literature Review with EPA WAM and other EPA economists	Within 4 weeks of receiving technical direction
5b	Presentation of Alternative Approaches, Results, and Discussion with EPA WAM and other EPA economists	Within 12 weeks of receiving technical direction
5c	Completed Report	Within 12 weeks of receiving technical direction or in consultation with the EPA WAM
6	Technical papers on recommendations from SAB panel report	Upon direction from EPA WAM
	CGE code or data processing code	Upon direction from EPA WAM

VI. QA Requirements:

With any analysis provided to EPA, the Contractor shall provide an assessment of the quality and appropriateness of any data used in the analysis. The QA report should discuss the data used with respect to precision, accuracy, representativeness, comparability, completeness, sensitivity, and appropriateness as it applies to this use. If existing QA data is available, the Contractor shall provide the WAM instructions to access it.

VII. Reporting Requirements:

The Contractor shall provide monthly progress reports in accordance with the terms of the contract. The Contractor shall submit work products in electronic as well as hard copy form. In addition, the Contractor shall deliver to the WAM each draft and final report in electronic format that is readable by windows-based word-processing (Microsoft Word 2013), graphics (Microsoft PowerPoint 2013), spreadsheet (Excel 2013), and database (Access 2013) programs. The Contractor shall also provide electronic copies of reports in PDF format. The Contractor shall also provide electronic copies of model files in General Algebraic Modeling System (GAMS) or other appropriate software programs.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000009

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 05/31/2018 Base Option Period Number 4	Economic-Wide Modeling Support

Contractor	Specify Section and paragraph of Contract SOW
Research Triangle Institute	1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2018

Comments:
This amendment formalizes the direction given by the CO on 11/29/17, via e-mail, to extend the current option period (4), period of performance, for 6 months (ending 05/31/2018). Contractor shall proceed with WA, revising cost estimate if needed. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

SFO (*Max 2*) ☐

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

	Cost/Fee:	LOE:
Contract Period: 04/01/2011 To 05/31/2018		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE:
Contractor WP Dated:		
Cumulative Approved:	Cost/Fee	LOE:

Work Assignment Manager Name: Jenny Thomas (Signature) (Date)	Branch/Mail Code: Phone Number: 202-564-4524 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000010

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 11/30/2018	
	Base Option Period Number 4	

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW:

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 11/30/2018

Comments:
This amendment extends the current option period (4) for 6 months (ending 11/30/2018). Contractor shall proceed with work assignment, revising cost estimate if needed. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

	Contract Period:	Cost/Fee:	LOE:
	06/01/2017 To 11/30/2018		
This Action:			
Total:			

Work Plan / Cost Estimate Approvals

Contractor WP Dated:	Cost/Fee	LOE:
Cumulative Approved:	Cost/Fee	LOE:

Work Assignment Manager Name: Jenny Thomas (Signature) (Date)	Branch/Mail Code: Phone Number: 202-564-4524 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000011

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 11/30/2018 Base Option Period Number 4	Economic-Wide Modeling Support

Contractor	Specify Section and paragraph of Contract SOW
Research Triangle Institute	1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 11/30/2018

Comments:
See attached SOW with highlighted changes. Contractor shall prepare a revised work plan/cost estimate in response to the amended SOW. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

Contract Period:	Cost/Fee:	LOE:
06/01/2017 To 11/30/2018		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

Contractor WP Dated:	Cost/Fee	LOE:
Cumulative Approved:	Cost/Fee	LOE:

Work Assignment Manager Name: Jenny Thomas (Signature) (Date)	Branch/Mail Code: Phone Number: 202-564-4524 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

Statement of Work – Amendment 11

I. Title: Economy-Wide Modeling Support
Contractor Name: Research Triangle Institute
Contract #: EP-W-11-029
WA #: 4-08

II. Work Assignment Manager (WAM):

Jenny Thomas
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-0306

Alternate WAM
Alex Macpherson
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-9770

III. Background:

Through this work assignment the contractor will support the U.S. EPA in developing its economy-wide modeling capabilities. The contractor will assist the U.S. EPA in development of a new Computable General Equilibrium (CGE) models, development of technical papers, and in applications of CGE Models.

The U.S. EPA Science Advisory Board panel on Economy-wide Modeling of the Benefits and Costs of Environmental Regulation is expected to submit a final report to the Agency in 2017. The contractor may assist in U.S. EPA in the development of technical papers surrounding the panel's recommendations as well as incorporating the panel's recommendations in the next generation of CGE models.

The contractor will also work with the Agency to lay the groundwork for developing next generation CGE models that meet the Agency's needs for flexibility, transparency, and cost-effectiveness. The work shall build on the Agency's history with the EMPAX

modelling framework while also drawing upon the current state of the science in the CGE modelling community.

The contractor shall not duplicate work performed under other current or previous contracts.

IV. Description and Tasks:

The WAM is authorized to provide technical direction in accordance with the contract. In accordance with the contract SOW, the contractor shall perform the following tasks:

Task #1: Prepare Work Plan

The contractor shall prepare a work plan for this WA in accordance with the contract. For this amendment, the work plan should address the increase amount only. The contractor shall submit this work plan to the WAM within 20 days of the effective date of the WA. The contractor shall contact the WAM by phone within 5 days of the effective date of the WA to discuss progress on the work plan.

Tasks #2 and #3 are complete and were removed in previous amendment.

Task #4: Develop and Document New CGE Platform

Task #4a: Develop data platform (baseline setting and calibration)

The contractor shall develop a baseline dataset for a CGE model calibrated to external forecasts, including the Annual Energy Outlook. The time series of social accounting matrices shall contribute to both static and dynamic CGE models to be developed in future.

Task #4b: Develop supporting technical document

The contractor shall develop a technical paper presenting the methodology and associated data analysis and the advantages and disadvantages of the approach relative to alternative approaches. The paper would outline options for alternative transition paths.

Task #4c: Regionalization of social accounting matrices

Building on the work done under task 4a to establish a national baseline dataset calibrated to external forecasts, the contractor shall develop a baseline dataset for a CGE model using a flexible methodology that allows for alternative regional structures. This methodology should be directly incorporated into the baseline setting and calibration process already under development (task 4a). This baseline dataset will consist of a time series of social accounting matrices with regional detail calibrated to external forecasts, including the Annual Energy Outlook. The exact number of regions for a prototype model version will be determined in coordination with the EPA WAM. For estimating

purposes, the contractor may assume dividing the working national-level dataset developed under task 4a into nine Census Divisions.

When developing the regionalization algorithm and dataset, the contractor shall examine the residual that remains after the algorithm solves and work to minimize this residual value as appropriate.

Task #4d: Sensitivity testing

In coordination with task 4c, the contractor shall explore the sensitivities of the calibration procedure used to develop the set of balanced social accounting matrices in tasks 4a and 4c to important modeling considerations. The contractor shall explore how the calibration procedure reacts varying important model dimensions – e.g. time, sectoral, geographic, and household dimensions. The specific design of tests of the calibration procedure shall be decided upon in coordination with the EPA WAM and documented via technical direction prior to the initiation of testing.

In designing and conducting these tests, the contractor shall be mindful that the ultimate goal of this work is to understand the tradeoffs in the calibration process to allow for the development of a flexible calibration procedure that can allow for changing resolutions of the model as needed for a specific application. For example, one application may require greater sectoral detail, while a different application may require more geographic detail. The contractor shall document the findings of this testing of the calibration along with any recommendations in a report to the EPA WAM.

Task #4e: Parameterization and Documentation

Continuing the development of a new CGE platform, the contractor shall work with the U.S. EPA to parameterize the mathematical equations used in the new CGE model. The model equations will be used in static and dynamic CGE models. This work will be initiated at the request of the EPA WAM via technical direction. The choice of functional forms and parameters shall be developed in coordination with the U.S. EPA and based on relevant literature. Sensitivity testing of the selected parameters may also be requested by the EPA WAM via technical direction.

The contractor shall document the selected functional forms and parameters in supporting technical documentation submitted to the EPA WAM.

Task #4f: Develop Baseline Dataset using Publicly-Available Data

While the CGE models are often necessarily built using datasets requiring a license (e.g. IMPLAN data), as part of ongoing efforts to construct a dynamic CGE model that uses exclusively open-source data, as part of this task the contractor will work with the EPA WAM in exploring the use of Bureau of Economic Analysis Benchmark Input-Output

Accounts data[1] to construct a social accounting matrix. The contractor shall present to the EPA WAM other open source datasets for consideration under this task. The contractor shall work with the EPA WAM to develop code processing the BEA data into a form for processing by the baseline setting and calibration and regionalization procedure developed under tasks 4a and 4c. The contractor shall work with the EPA WAM to resolve any challenges encountered in (1) manipulating the data for use in the baseline setting process and (2) any challenges encountered in processing this data using the baseline-setting code.

Task #4g: Disaggregation of the Power Sector in the CGE Model

Given the importance of the power sector, there is often interest in a detailed understanding of the impacts of a regulation on this sector. In order to assist in such an analysis, the contractor shall disaggregate the power sector in the CGE model developed throughout task 4. In disaggregating the power sector, the contractor may develop two alternate approaches: (1) based on fuel share data from EIA and (2) based on the MEEDE dataset. Where the MEEDE dataset is used, the contractor shall provide a complete set of MEEDE data. The contractor shall draw upon data and experience from the development of the publication *Construction and application of the MEEDE dataset*[2] in completing this task.

When pursuing the power sector disaggregation, the contractor may encounter important decision points where input from the EPA WAM is needed. The contractor shall develop a memo of any such important decision points for discussion with the EPA WAM and other EPA staff.

When developing the power sector disaggregation algorithm and dataset, the contractor shall examine the residual that remains after the algorithm solves and work to minimize this residual value as appropriate.

The contractor shall document the process used to accomplish this disaggregation and share with the EPA WAM code developed as part of this work. The contractor shall also edit the code for baseline setting and calibration and regionalization developed under tasks 4a and 4c to be compatible with a disaggregated power sector. Code produced as part of this effort shall be considered open source.

Task #4h: Complete Set of Codes and Supporting Documentation

The contractor shall deliver to the EPA WAM a complete set of codes for all of the work completed under Task 4. This comprehensive set of codes shall be a "clean" set of code (i.e. no extraneous code commented out, unnecessary notes, etc.) organized in an appropriate file structure. The file structure may include accompanying .txt files to explain the organization, order in which to run files, etc. The code should be organized

[1] https://www.bea.gov/industry/index.htm#benchmark_io

[2] https://www.rti.org/rti-press-publication/construction-and-application-meede-dataset

such that the EPA WAM could open the file and understand in what order to run the code to step through the entire baseline-setting process. The contractor shall also assist the EPA WAM in identifying reasonable scenarios to run in the baseline-setting model to become familiar with the baseline data.

The contractor shall also assist the EPA WAM in identifying the appropriate set of codes to post to an internal GitHub repository, for sharing with other EPA staff.

In addition to providing a clean set of codes, the contractor shall develop accompanying comprehensive documentation of the entire baseline-setting and disaggregation process developed in Task 4. This document will include a chapter for each major component of the baseline-setting process, ideally coordinated with a corresponding folder in the code file structure; though the contractor may discuss organization of the document with the EPA WAM.

The clean set of code and accompanying documentation shall be delivered to the EPA WAM no later than the end of the contract period (currently November 30, 2018.)

Task #5: Case Study: Linking Partial and General Equilibrium Models

There are no changes to task 5.

Task #6: Technical Assistance on Recommendations from Science Advisory Board Panel Report

There are no changes to task 6.

V. DELIVERABLES:

The Contractor shall meet bi-weekly with EPA for regular updates and adhere to the following schedule:

Task	Deliverable	Due date
1	Work Plan	Within 20 days of the effective date of WA
2	*Tasks 2 and 3 are complete.*	
3		
4a	Develop data platform (baseline setting and calibration)	Upon direction by WAM

4b	Develop supporting technical document	Upon direction by WAM
4c	Develop regionalized baseline dataset	Upon direction from EPA WAM.
4d	Test calibration procedure and document results in a report to EPA WAM.	Upon direction from EPA WAM.
4e	Parameterize mathematical equations and complete technical documentation.	Upon direction from EPA WAM
4f	Develop baseline dataset using publicly-available data	Upon direction from EPA WAM
4g	Disaggregate energy sector in CGE	Upon direction from EPA WAM
4h	Complete set of codes and documentation	No later than the end of the contract period (November 30, 2018.)
5a	Presentation of Literature Review with EPA WAM and other EPA economists	Within 4 weeks of receiving technical direction
5b	Presentation of Alternative Approaches, Results, and Discussion with EPA WAM and other EPA economists	Within 12 weeks of receiving technical direction
5c	Completed Report	Within 12 weeks of receiving technical direction or in consultation with the EPA WAM
6	Technical papers on recommendations from SAB panel report	Upon direction from EPA WAM
	CGE code or data processing code	Upon direction from EPA WAM

VI. QA Requirements:

With any analysis provided to EPA, the Contractor shall provide an assessment of the quality and appropriateness of any data used in the analysis. The QA report should discuss the data used with respect to precision, accuracy, representativeness, comparability, completeness, sensitivity, and appropriateness as it applies to this use. If existing QA data is available, the Contractor shall provide the WAM instructions to access it.

VII. Reporting Requirements:

The Contractor shall provide monthly progress reports in accordance with the terms of the contract. The Contractor shall submit work products in electronic as well as hard copy form. In addition, the Contractor shall deliver to the WAM each draft and final report in electronic format that is readable by windows-based word-processing (Microsoft Word 2013), graphics (Microsoft PowerPoint 2013), spreadsheet (Excel 2013), and database (Access 2013) programs. The Contractor shall also provide electronic copies of reports in PDF format. The Contractor shall also provide electronic copies of model files in General Algebraic Modeling System (GAMS) or other appropriate software programs.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000012

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 02/28/2019	Economic-Wide Modeling Support
	Base Option Period Number 4	

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 02/28/2019

Comments:
See attached revised SOW (changes highlighted in yellow). Contractor shall prepare a revised work plan/cost estimate in response to the amended SOW. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

	Contract Period:	Cost/Fee:	LOE:
	06/01/2017 To 02/28/2019		
This Action:			
Total:			

Work Plan / Cost Estimate Approvals

Contractor WP Dated:	Cost/Fee	LOE:
Cumulative Approved:	Cost/Fee	LOE:

Work Assignment Manager Name: Jenny Thomas (Signature) (Date)	Branch/Mail Code: Phone Number: 202-564-4524 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

Statement of Work – Amendment 9

I. Title: Economy-Wide Modeling Support
Contractor Name: Research Triangle Institute
Contract #: EP-W-11-029
WA #: 4-08

II. Work Assignment Manager (WAM):

Jenny Thomas
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-0306

Alternate WAM
Alex Macpherson
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-9770

III. Background:

Through this work assignment the contractor will support the U.S. EPA in developing its economy-wide modeling capabilities. The contractor will assist the U.S. EPA in development of a new Computable General Equilibrium (CGE) models, development of technical papers, and in applications of CGE Models.

The U.S. EPA Science Advisory Board panel on Economy-wide Modeling of the Benefits and Costs of Environmental Regulation is expected to submit a final report to the Agency in 2017. The contractor may assist in U.S. EPA in the development of technical papers surrounding the panel's recommendations as well as incorporating the panel's recommendations in the next generation of CGE models.

The contractor will also work with the Agency to lay the groundwork for developing next generation CGE models that meet the Agency's needs for flexibility, transparency, and cost-effectiveness. The work shall build on the Agency's history with the EMPAX

modelling framework while also drawing upon the current state of the science in the CGE modelling community.

The contractor shall not duplicate work performed under other current or previous contracts.

IV. Description and Tasks:

The WAM is authorized to provide technical direction in accordance with the contract. In accordance with the contract SOW, the contractor shall perform the following tasks:

Task #1: Prepare Work Plan

The contractor shall prepare a work plan for this WA in accordance with the contract. For this amendment, the work plan should address the increase amount only. The contractor shall submit this work plan to the WAM within 20 days of the effective date of the WA. The contractor shall contact the WAM by phone within 5 days of the effective date of the WA to discuss progress on the work plan.

Tasks #2 and #3 are complete and were removed in previous amendment.

Task #4: Develop and Document New CGE Platform

Task #4a: Develop data platform (baseline setting and calibration)

The contractor shall develop a baseline dataset for a CGE model calibrated to external forecasts, including the Annual Energy Outlook. The time series of social accounting matrices shall contribute to both static and dynamic CGE models to be developed in future.

Task #4b: Develop supporting technical document

The contractor shall develop a technical paper presenting the methodology and associated data analysis and the advantages and disadvantages of the approach relative to alternative approaches. The paper would outline options for alternative transition paths.

Task #4c: Regionalization of social accounting matrices

Building on the work done under task 4a to establish a national baseline dataset calibrated to external forecasts, the contractor shall develop a baseline dataset for a CGE model using a flexible methodology that allows for alternative regional structures. This methodology should be directly incorporated into the baseline setting and calibration process already under development (task 4a). This baseline dataset will consist of a time series of social accounting matrices with regional detail calibrated to external forecasts, including the Annual Energy Outlook. The exact number of regions for a prototype model version will be determined in coordination with the EPA WAM. For estimating

purposes, the contractor may assume dividing the working national-level dataset developed under task 4a into nine Census Divisions.

When developing the regionalization algorithm and dataset, the contractor shall examine the residual that remains after the algorithm solves and work to minimize this residual value as appropriate.

Task #4d: Sensitivity testing

In coordination with task 4c, the contractor shall explore the sensitivities of the calibration procedure used to develop the set of balanced social accounting matrices in tasks 4a and 4c to important modeling considerations. The contractor shall explore how the calibration procedure reacts varying important model dimensions – e.g. time, sectoral, geographic, and household dimensions. The specific design of tests of the calibration procedure shall be decided upon in coordination with the EPA WAM and documented via technical direction prior to the initiation of testing.

In designing and conducting these tests, the contractor shall be mindful that the ultimate goal of this work is to understand the tradeoffs in the calibration process to allow for the development of a flexible calibration procedure that can allow for changing resolutions of the model as needed for a specific application. For example, one application may require greater sectoral detail, while a different application may require more geographic detail. The contractor shall document the findings of this testing of the calibration along with any recommendations in a report to the EPA WAM.

Task #4e: Parameterization and Documentation

Continuing the development of a new CGE platform, the contractor shall work with the U.S. EPA to parameterize the mathematical equations used in the new CGE model. The model equations will be used in static and dynamic CGE models. This work will be initiated at the request of the EPA WAM via technical direction. The choice of functional forms and parameters shall be developed in coordination with the U.S. EPA and based on relevant literature. Sensitivity testing of the selected parameters may also be requested by the EPA WAM via technical direction.

The contractor shall document the selected functional forms and parameters in supporting technical documentation submitted to the EPA WAM.

Task #4f: Develop Baseline Dataset using Publicly-Available Data

While the CGE models are often necessarily built using datasets requiring a license (e.g. IMPLAN data), as part of ongoing efforts to construct a dynamic CGE model that uses exclusively open-source data, as part of this task the contractor will work with the EPA WAM in exploring the use of Bureau of Economic Analysis Benchmark Input-Output

Accounts data[1] to construct a social accounting matrix. The contractor shall present to the EPA WAM other open source datasets for consideration under this task. The contractor shall work with the EPA WAM to develop code processing the BEA data into a form for processing by the baseline setting and calibration and regionalization procedure developed under tasks 4a and 4c. The contractor shall work with the EPA WAM to resolve any challenges encountered in (1) manipulating the data for use in the baseline setting process and (2) any challenges encountered in processing this data using the baseline-setting code.

Task #4g: Disaggregation of the Power Sector in the CGE Model

Given the importance of the power sector, there is often interest in a detailed understanding of the impacts of a regulation on this sector. In order to assist in such an analysis, the contractor shall disaggregate the power sector in the CGE model developed throughout task 4. In disaggregating the power sector, the contractor may develop two alternate approaches: (1) based on fuel share data from EIA and (2) based on the MEEDE dataset. Where the MEEDE dataset is used, the contractor shall provide a complete set of MEEDE data. The contractor shall draw upon data and experience from the development of the publication Construction and application of the MEEDE dataset[2] in completing this task.

When pursuing the power sector disaggregation, the contractor may encounter important decision points where input from the EPA WAM is needed. The contractor shall develop a memo of any such important decision points for discussion with the EPA WAM and other EPA staff.

When developing the power sector disaggregation algorithm and dataset, the contractor shall examine the residual that remains after the algorithm solves and work to minimize this residual value as appropriate.

The contractor shall document the process used to accomplish this disaggregation and share with the EPA WAM code developed as part of this work. The contractor shall also edit the code for baseline setting and calibration and regionalization developed under tasks 4a and 4c to be compatible with a disaggregated power sector. Code produced as part of this effort shall be considered open source.

Task #4h: Complete Set of Codes and Supporting Documentation

The contractor shall deliver to the EPA WAM a complete set of codes for all of the work completed under Task 4. This comprehensive set of codes shall be a "clean" set of code (i.e. no extraneous code commented out, unnecessary notes, etc.) organized in an appropriate file structure. The file structure may include accompanying .txt files to explain the organization, order in which to run files, etc. The code should be organized

[1] https://www.bea.gov/industry/index.htm#benchmark_io

[2] https://www.rti.org/rti-press-publication/construction-and-application-meede-dataset

such that the EPA WAM could open the file and understand in what order to run the code to step through the entire baseline-setting process. The contractor shall also assist the EPA WAM in identifying reasonable scenarios to run in the baseline-setting model to become familiar with the baseline data.

The contractor shall also assist the EPA WAM in identifying the appropriate set of codes to post to an internal GitHub repository, for sharing with other EPA staff.

In addition to providing a clean set of codes, the contractor shall develop accompanying comprehensive documentation of the entire baseline-setting and disaggregation process developed in Task 4. This document will include a chapter for each major component of the baseline-setting process, ideally coordinated with a corresponding folder in the code file structure; though the contractor may discuss organization of the document with the EPA WAM.

The clean set of code and accompanying documentation shall be delivered to the EPA WAM no later than the end of the contract period (currently November 30, 2018.)

In the extension period following November 30, 2018, the contractor shall work with the EPA WAM to incorporate any comments or feedback from the EPA WAM. These comments may include edits to documentation language, suggested additions to the documentation, and clarification or edits to the accompanying code.

Task #5: Case Study: Linking Partial and General Equilibrium Models

There are no changes to task 5.

Task #6: Technical Assistance on Recommendations from Science Advisory Board Panel Report

There are no changes to task 6.

Task #7: Electricity Sector Data Development

In support of work done under Task 4g the contractor shall update and improve the automation of construction the MEEDE power sector dataset. In completing this update, the contractor shall utilize the most recent editions of all of the source data used in compiling the MEEDE dataset. Compilation of the MEEDE dataset requires the utilization and harmonization of several different data source and, to the extent possible, the contractor shall work to automate the build stream. Additionally, the contractor shall plan to prepare documentation describing the compilation process, key decisions, and summary statistics on the resulting data. The contractor shall also prepare code suitable for public release and appropriately commented to assist a user in following the program. Given that the previous MEEDE work was completed STATA, for this phase of the project the contractor may anticipate continuing to use that program.

The resulting updated MEEDE dataset may be run through the algorithm for electricity sector disaggregation developed under task 4g, and results compared. The updated dataset may also be used by the EPA for other purposes and released publicly.

V. DELIVERABLES:

The Contractor shall meet bi-weekly with EPA for regular updates and adhere to the following schedule:

Task	Deliverable	Due date
1	Work Plan	Within 20 days of the effective date of WA
2	Tasks 2 and 3 are complete.	
3		
4a	Develop data platform (baseline setting and calibration)	Upon direction by WAM
4b	Develop supporting technical document	Upon direction by WAM
4c	Develop regionalized baseline dataset	Upon direction from EPA WAM.
4d	Test calibration procedure and document results in a report to EPA WAM.	Upon direction from EPA WAM.
4e	Parameterize mathematical equations and complete technical documentation.	Upon direction from EPA WAM
4f	Develop baseline dataset using publicly-available data	Upon direction from EPA WAM
4g	Disaggregate energy sector in CGE	Upon direction from EPA WAM
4h	Complete set of codes and documentation	No later than the end of the contract period (November 30, 2018.)
4h	Revisions to documentation and accompanying codes.	At the request of the EPA WAM

5a	Presentation of Literature Review with EPA WAM and other EPA economists	Within 4 weeks of receiving technical direction
5b	Presentation of Alternative Approaches, Results, and Discussion with EPA WAM and other EPA economists	Within 12 weeks of receiving technical direction
5c	Completed Report	Within 12 weeks of receiving technical direction or in consultation with the EPA WAM
6	Technical papers on recommendations from SAB panel report	Upon direction from EPA WAM
	CGE code or data processing code	Upon direction from EPA WAM
7	Updated code to compile electricity sector data and resulting dataset	Upon direction from EPA WAM

VI. QA Requirements:

With any analysis provided to EPA, the Contractor shall provide an assessment of the quality and appropriateness of any data used in the analysis. The QA report should discuss the data used with respect to precision, accuracy, representativeness, comparability, completeness, sensitivity, and appropriateness as it applies to this use. If existing QA data is available, the Contractor shall provide the WAM instructions to access it.

VII. Reporting Requirements:

The Contractor shall provide monthly progress reports in accordance with the terms of the contract. The Contractor shall submit work products in electronic as well as hard copy form. In addition, the Contractor shall deliver to the WAM each draft and final report in electronic format that is readable by windows-based word-processing (Microsoft Word 2013), graphics (Microsoft PowerPoint 2013), spreadsheet (Excel 2013), and database (Access 2013) programs. The Contractor shall also provide electronic copies of reports in PDF format. The Contractor shall also provide electronic copies of model files in General Algebraic Modeling System (GAMS) or other appropriate software programs.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000013

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 05/31/2019 Base Option Period Number 4	Economic-Wide Modeling Supp

Contractor	Specify Section and paragraph of Contract SOW
Research Triangle Institute	1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2019

Comments:
The purpose of this amendment is to make Alex Macpherson primary WAM/COR on this work assignment. His contact information as follows: macpherson.alex@epa.gov, 919-541-9770.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

Contract Period: 06/01/2017 To 05/31/2019 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Alex Macpherson (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-9770 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000014

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 09/30/2019 Base Option Period Number 4	Economic-Wide Modeling Supp

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW: 1,3,4,6,7,8,11,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 05/31/2019

Comments:
See revised SOW (changes highlighted in yellow). Contractor shall prepare a revised work plan/cost estimate in response to the amended SOW. No previously performed work shall be duplicated.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

Contract Period: 06/01/2017 To 09/30/2019 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Alex Macpherson (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-9770 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

Statement of Work – Amendment 14

I. Title: Economy-Wide Modeling Support
Contractor Name: Research Triangle Institute
Contract #: EP-W-11-029
WA #: 4-08

II. Work Assignment Manager (WAM):

Alex Macpherson
U.S. Environmental Protection Agency
Office of Air Quality Planning and Standards
Health and Environmental Impacts Division
Air Economics Group, C439-02
Research Triangle Park, NC 27711
Phone: (919) 541-9770

III. Background:

Through this work assignment the contractor will support the U.S. EPA in developing its economy-wide modeling capabilities. The contractor will assist the U.S. EPA in development of a new Computable General Equilibrium (CGE) models, development of technical papers, and in applications of CGE Models.

The U.S. EPA Science Advisory Board panel on Economy-wide Modeling of the Benefits and Costs of Environmental Regulation is expected to submit a final report to the Agency in 2017. The contractor may assist in U.S. EPA in the development of technical papers surrounding the panel's recommendations as well as incorporating the panel's recommendations in the next generation of CGE models.

The contractor will also work with the Agency to lay the groundwork for developing next generation CGE models that meet the Agency's needs for flexibility, transparency, and cost-effectiveness. The work shall build on the Agency's history with the EMPAX modelling framework while also drawing upon the current state of the science in the CGE modelling community.

The contractor shall not duplicate work performed under other current or previous contracts.

IV. Description and Tasks:

The WAM is authorized to provide technical direction in accordance with the contract. In accordance with the contract SOW, the contractor shall perform the following tasks:

Task #1: Prepare Work Plan

The contractor shall prepare a work plan for this WA in accordance with the contract. For this amendment, the work plan should address the increase amount only. The contractor shall submit this work plan to the WAM within 20 days of the effective date of the WA. The contractor shall contact the WAM by phone within 5 days of the effective date of the WA to discuss progress on the work plan.

Tasks #2 and #3 are complete and were removed in previous amendment.

Task #4: Develop and Document New CGE Platform

Task #4a: Develop data platform (baseline setting and calibration)

The contractor shall develop a baseline dataset for a CGE model calibrated to external forecasts, including the Annual Energy Outlook. The time series of social accounting matrices shall contribute to both static and dynamic CGE models to be developed in future.

Task #4b: Develop supporting technical document

The contractor shall develop a technical paper presenting the methodology and associated data analysis and the advantages and disadvantages of the approach relative to alternative approaches. The paper would outline options for alternative transition paths.

Task #4c: Regionalization of social accounting matrices

Building on the work done under task 4a to establish a national baseline dataset calibrated to external forecasts, the contractor shall develop a baseline dataset for a CGE model using a flexible methodology that allows for alternative regional structures. This methodology should be directly incorporated into the baseline setting and calibration process already under development (task 4a). This baseline dataset will consist of a time series of social accounting matrices with regional detail calibrated to external forecasts, including the Annual Energy Outlook. The exact number of regions for a prototype model version will be determined in coordination with the EPA WAM. For estimating purposes, the contractor may assume dividing the working national-level dataset developed under task 4a into nine Census Divisions.

When developing the regionalization algorithm and dataset, the contractor shall examine the residual that remains after the algorithm solves and work to minimize this residual value as appropriate.

Task #4d: Sensitivity testing

In coordination with task 4c, the contractor shall explore the sensitivities of the calibration procedure used to develop the set of balanced social accounting matrices in

tasks 4a and 4c to important modeling considerations. The contractor shall explore how the calibration procedure reacts varying important model dimensions – e.g. time, sectoral, geographic, and household dimensions. The specific design of tests of the calibration procedure shall be decided upon in coordination with the EPA WAM and documented via technical direction prior to the initiation of testing.

In designing and conducting these tests, the contractor shall be mindful that the ultimate goal of this work is to understand the tradeoffs in the calibration process to allow for the development of a flexible calibration procedure that can allow for changing resolutions of the model as needed for a specific application. For example, one application may require greater sectoral detail, while a different application may require more geographic detail. The contractor shall document the findings of this testing of the calibration along with any recommendations in a report to the EPA WAM.

Task #4e: Parameterization and Documentation

Continuing the development of a new CGE platform, the contractor shall work with the U.S. EPA to parameterize the mathematical equations used in the new CGE model. The model equations will be used in static and dynamic CGE models. This work will be initiated at the request of the EPA WAM via technical direction. The choice of functional forms and parameters shall be developed in coordination with the U.S. EPA and based on relevant literature. Sensitivity testing of the selected parameters may also be requested by the EPA WAM via technical direction.

The contractor shall document the selected functional forms and parameters in supporting technical documentation submitted to the EPA WAM.

Task #4f: Develop Baseline Dataset using Publicly-Available Data

While the CGE models are often necessarily built using datasets requiring a license (e.g. IMPLAN data), as part of ongoing efforts to construct a dynamic CGE model that uses exclusively open-source data, as part of this task the contractor will work with the EPA WAM in exploring the use of Bureau of Economic Analysis Benchmark Input-Output Accounts data[1] to construct a social accounting matrix. The contractor shall present to the EPA WAM other open source datasets for consideration under this task. The contractor shall work with the EPA WAM to develop code processing the BEA data into a form for processing by the baseline setting and calibration and regionalization procedure developed under tasks 4a and 4c. The contractor shall work with the EPA WAM to resolve any challenges encountered in (1) manipulating the data for use in the baseline setting process and (2) any challenges encountered in processing this data using the baseline-setting code.

Task #4g: Disaggregation of the Power Sector in the CGE Model

[1] https://www.bea.gov/industry/index.htm#benchmark_io

Given the importance of the power sector, there is often interest in a detailed understanding of the impacts of a regulation on this sector. In order to assist in such an analysis, the contractor shall disaggregate the power sector in the CGE model developed throughout task 4. In disaggregating the power sector, the contractor may develop two alternate approaches: (1) based on fuel share data from EIA and (2) based on the MEEDE dataset. Where the MEEDE dataset is used, the contractor shall provide a complete set of MEEDE data. The contractor shall draw upon data and experience from the development of the publication Construction and application of the MEEDE dataset[2] in completing this task.

When pursuing the power sector disaggregation, the contractor may encounter important decision points where input from the EPA WAM is needed. The contractor shall develop a memo of any such important decision points for discussion with the EPA WAM and other EPA staff.

When developing the power sector disaggregation algorithm and dataset, the contractor shall examine the residual that remains after the algorithm solves and work to minimize this residual value as appropriate.

The contractor shall document the process used to accomplish this disaggregation and share with the EPA WAM code developed as part of this work. The contractor shall also edit the code for baseline setting and calibration and regionalization developed under tasks 4a and 4c to be compatible with a disaggregated power sector. Code produced as part of this effort shall be considered open source.

Task #4h: Complete Set of Codes and Supporting Documentation

The contractor shall deliver to the EPA WAM a complete set of codes for all of the work completed under Task 4. This comprehensive set of codes shall be a "clean" set of code (i.e. no extraneous code commented out, unnecessary notes, etc.) organized in an appropriate file structure. The file structure may include accompanying .txt files to explain the organization, order in which to run files, etc. The code should be organized such that the EPA WAM could open the file and understand in what order to run the code to step through the entire baseline-setting process. The contractor shall also assist the EPA WAM in identifying reasonable scenarios to run in the baseline-setting model to become familiar with the baseline data.

The contractor shall also assist the EPA WAM in identifying the appropriate set of codes to post to an internal GitHub repository, for sharing with other EPA staff.

In addition to providing a clean set of codes, the contractor shall develop accompanying comprehensive documentation of the entire baseline-setting and disaggregation process developed in Task 4. This document will include a chapter for each major component of the baseline-setting process, ideally coordinated with a corresponding folder in the code

[2] https://www.rti.org/rti-press-publication/construction-and-application-meede-dataset

file structure; though the contractor may discuss organization of the document with the EPA WAM.

The clean set of code and accompanying documentation shall be delivered to the EPA WAM no later than the end of the contract period (currently November 30, 2018.)

In the extension period following November 30, 2018, the contractor shall work with the EPA WAM to incorporate any comments or feedback from the EPA WAM. These comments may include edits to documentation language, suggested additions to the documentation, and clarification or edits to the accompanying code.

Task #5: Case Study: Linking Partial and General Equilibrium Models

There are no changes to task 5.

Task #6: Technical Assistance on Recommendations from Science Advisory Board Panel Report

The Science Advisory Board Panel report on Economy-Wide Modeling said when detailed information on pollution abatement expenditures is available, factor-specific productivity impacts can be used to construct a regulatory shock within an CGE. However, changes in rules such as the National Ambient Air Quality Standards (NAAQS) can impose compliance costs in the billions of dollars across many sectors of the economy, presenting challenges with the development of detailed information on projected abatement expenditures. For example, what fraction of compliance expenditures are on capital equipment versus expenditures on labor? What are the inputs to pollution control capital? For example, does the control capital require steel, chemicals or other inputs?

The contractor shall work with the EPA WAM to identify a prototype decomposition of abatement expenditures for an important control technology and use this prototype to disaggregate the expenditures a subset of important abatement technologies. The specific technologies to be examined will be determined in collaboration with EPA staff.
The research strategy shall first rely upon EPA information resources such as the EPA Control Strategies Tool (CoST) and the associated Control Measures Database (CMDB), the EPA Air Pollution Control Control Cost Manual, and relevant regulatory impact and economic impact analyses. If needed, research outside of these EPA resources shall be performed contingent on direction from the EPA WAM.

Preliminary detail on information to be collected follows:

- Installation and capital costs. For identified set of control technologies, identify the shares of capital and labor-related expenditures on installation of controls. If other intermediate inputs are used in the installation of the control equipment, the expenditure shares for those inputs are also needed.

- Variable costs. The share of expenditure by input (labor versus specific intermediates) is needed for variable and fixed costs associated with operating the control equipment annually.
- Further details:
  - Installation expenditures should not be annualized or include any financing factors.
  - If possible, obtain the deprecation rate of the control equipment.
- Maintenance expenditures should be separated from other flow costs, as the CGE model will internally track depreciation and required investments associated with maintenance.
- All expenditures should be valued net of taxes.
- The dollar year should be provided.

The contractor shall document the research process used and the cost decomposition in a technical memo and supporting spreadsheets delivered to the EPA WAM.

Task #7: Electricity Sector Data Development

In support of work done under Task 4g the contractor shall update and improve the automation of construction the MEEDE power sector dataset. In completing this update, the contractor shall utilize the most recent editions of all of the source data used in compiling the MEEDE dataset. Compilation of the MEEDE dataset requires the utilization and harmonization of several different data source and, to the extent possible, the contractor shall work to automate the build stream. Additionally, the contractor shall plan to prepare documentation describing the compilation process, key decisions, and summary statistics on the resulting data. The contractor shall also prepare code suitable for public release and appropriately commented to assist a user in following the program. Given that the previous MEEDE work was completed STATA, for this phase of the project the contractor may anticipate continuing to use that program.

The resulting updated MEEDE dataset may be run through the algorithm for electricity sector disaggregation developed under task 4g, and results compared. The updated dataset may also be used by the EPA for other purposes and released publicly.

V. DELIVERABLES:

The Contractor shall meet bi-weekly with EPA for regular updates and adhere to the following schedule:

Task	Deliverable	Due date

1	Work Plan	Within 20 days of the effective date of WA
2	Tasks 2 and 3 are complete.	
3		
4a	Develop data platform (baseline setting and calibration)	Upon direction by WAM
4b	Develop supporting technical document	Upon direction by WAM
4c	Develop regionalized baseline dataset	Upon direction from EPA WAM.
4d	Test calibration procedure and document results in a report to EPA WAM.	Upon direction from EPA WAM.
4e	Parameterize mathematical equations and complete technical documentation.	Upon direction from EPA WAM
4f	Develop baseline dataset using publicly-available data	Upon direction from EPA WAM
4g	Disaggregate energy sector in CGE	Upon direction from EPA WAM
4h	Complete set of codes and documentation	No later than the end of the contract period (November 30, 2018.)
4h	Revisions to documentation and accompanying codes.	At the request of the EPA WAM
5a	Presentation of Literature Review with EPA WAM and other EPA economists	Within 4 weeks of receiving technical direction
5b	Presentation of Alternative Approaches, Results, and Discussion with EPA WAM and other EPA economists	Within 12 weeks of receiving technical direction
5c	Completed Report	Within 12 weeks of receiving technical direction or in consultation with the EPA WAM
6a	Decomposition prototype and list of air emission controls	To be selected in coordination with EPA WAM within 2 weeks of receiving technical direction.

6b	Preliminary draft technical memo and supporting spreadsheets. This may not be a complete draft, but rather cost decomposition results from 1-2 control technologies	Within 4 weeks of receiving technical direction.
6c	Complete draft technical memo and supporting spreadsheets.	Within 4 weeks of receiving technical direction.
6d	Final technical memo and supporting spreadsheets	Within 4 weeks of receiving technical direction.
	CGE code or data processing code	Upon direction from EPA WAM
7	Updated code to compile electricity sector data and resulting dataset	Upon direction from EPA WAM

VI. QA Requirements:

With any analysis provided to EPA, the Contractor shall provide an assessment of the quality and appropriateness of any data used in the analysis. The QA report should discuss the data used with respect to precision, accuracy, representativeness, comparability, completeness, sensitivity, and appropriateness as it applies to this use. If existing QA data is available, the Contractor shall provide the WAM instructions to access it.

VII. Reporting Requirements:

The Contractor shall provide monthly progress reports in accordance with the terms of the contract. The Contractor shall submit work products in electronic as well as hard copy form. In addition, the Contractor shall deliver to the WAM each draft and final report in electronic format that is readable by windows-based word-processing (Microsoft Word 2013), graphics (Microsoft PowerPoint 2013), spreadsheet (Excel 2013), and database (Access 2013) programs. The Contractor shall also provide electronic copies of reports in PDF format. The Contractor shall also provide electronic copies of model files in General Algebraic Modeling System (GAMS) or other appropriate software programs.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-08

☐ Other ☒ Amendment Number: 000015

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	06/01/2017 To 09/30/2019 Base X Option Period Number	

Contractor: Research Triangle Institute

Specify Section and paragraph of Contract SOW:

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 09/30/2019

Comments:
The purpose of this amendment is to extend the POP in accordance with P00097.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*): ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

Contract Period: 06/01/2017 To 09/30/2019 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Alex Macpherson (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-9770 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Christian Ford-Cannon (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-2147 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-09

☐ Other ☐ Amendment Number:

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016 Base Option Period Number 4	Texas Regional Haze Evaluation

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: Sections 2, 3, 15, 16, & 17

Purpose:
- [X] Work Assignment
- [ ] Work Assignment Amendment
- [ ] Work Plan Approval
- [ ] Work Assignment Close-Out
- [ ] Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
WA 4-09 Full Title: Texas Regional Haze Evaluation

This WA continues work on WA 3-09. See attached SOW. 200 hours are included for preparation of the work plan and to begin working on the WA.

☐ Superfund — Accounting and Appropriations Data — [X] Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code (Max 7)
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

	Cost/Fee:	LOE:
Contract Period: 04/01/2011 To 03/31/2016		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee:	LOE:
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Ellen Belk (Signature) (Date)	Branch/Mail Code: Phone Number: 214-665-2164 FAX Number:
Project Officer Name: Jolynn Collins (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5671 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Rodney-Daryl Jones (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3112 FAX Number:

I. **Title:** Texas Regional Haze Evaluation
Contractor Name: RTI International
Contract #: EP-W-11-029
WA #: 4-09

II. **Work Assignment Manager (WAM)**
WAM Name: Ellen H. Belk
U.S. Environmental Protection Agency
Office: EPA Region 6, Multi-Media Planning and Permitting Division
Division (Mail Code): 6PD-L
City, State, Zip Code: Dallas, TX 75202-2733
Phone: (area code) phone-number: 214-665-2164
Email: belk.ellen@epa.gov

III. Background

EPA R6 is presently under a court-ordered Consent Decree deadline regarding action on the Texas Regional Haze (RH) State Implementation Plan (SIP). The EPA must sign a proposal Federal Register action no later than November 26, 2014, and sign a final Federal Register action no later than September 4, 2015.

This Work Assignment concerns control strategy analyses and related support for potential air pollution controls that may be required to adequately address federal regional haze requirements as part of the Texas Regional Haze State Implementation Plan. These analyses include the following components: a) strategy development, b) emission changes, c) environmental quality changes, and d) cost impacts.

IV. Description and Tasks

Task 1: Work Plan

No new workplan is required. The Contractor will use the existing workplan developed by the Contractor under the previous period of performance.

The Contractor shall develop a revised cost estimate, including a breakdown of costs for each task and subtask in the cost estimate.

The Contractor shall hold conference calls with the WAM on a regular basis after approval of the work plan to plan and review progress of this WA.

Deliverables under Task 1

The revised Cost Estimate shall be delivered to the WAM as soon as possible but no later than 20 days following the effective date of the WA.

Task 2: Control Strategy Analyses: including Modeling Support

Purpose: Regional haze (RH) sensitivity modeling to evaluate potential impact of sources and potential emission reductions from sources on RH projections.

The results of this task will be reviewed and considered by EPA R6 as part of EPA R6's review and evaluation of the Texas RH State Implementation Plan (SIP).

Background: From approximately 2002 through 2007, the Central Regional Air Planning Association (CENRAP), hired contractors including the Environ Corp., in developing a very detailed photochemical modeling analysis for use by states in responding to requirements of the Clean Air Act. This modeling has been used by CENRAP states in developing their Regional Haze SIPs. The work required under this Work Assignment will build directly off of the above mentioned earlier CENRAP work, and will build on CENRAP's modeling files and post-analysis work.

Description: The Contractor shall utilize these modeling databases generated for CENRAP members to conduct photochemical modeling using PSAT source apportionment and Plume-In-Grid to identify impacts from selected sources or groups of sources identified by EPA Region 6. This entails using CAMx (latest version) and the CENRAP RH modeling files (2002 and 2018) that Environ Corp. has currently archived. In order to complete this work these several Terabytes of modeling data will need to be utilized and it is anticipated that some modifications and updating of emissions, including evaluating and deciding how to incorporate the reductions assumed under the Cross State Air Pollution Rule (CSAPR) and the Mercury and Air Toxics Standards (MATS), are most likely necessary to complete this work. This work is being conducted to help EPA R6 review and evaluate the Texas Regional Haze SIP. As required by Consent Decree, EPAR6 is concurrently developing a proposed action regarding the Texas Regional Haze SIP.

General Requirements: The Contractor shall provide EPA R6 with files and interim files periodically and also as requested, throughout the duration of this Work Assignment. This information will be used by EPA R6 for review and consideration of decisions on targeting sources for source apportionment modeling and potential emission reductions.

Schedule: This work shall be completed as soon as possible.

This work consists of the following sub-tasks:

TASK 2: Subtask 1: Preparing to conduct CAMx Source Apportionment:
Retrieving modeling files and updating emission files for a current analysis (2002 and 2018).

For this Subtask, the Contractor shall:

a) Retrieve the CENRAP modeling files for CAMx runs including emission files and processing files (F and G EI versions)[1]. Environ Corp. currently has these files archived on back-up drives from their previous contracting work for CENRAP. Environ conducted much of the original regional haze modeling for CENRAP and other RH modeling for other RPOs.

b) Using the older CAMx ready files ('F' EI versions) that can be used for source apportionment and that still have facility location specific information, update the files (Typ02F and Base18F) to reflect the final changes incorporated in the final CENRAP modeling CMAQ runs: 2002 base case (Typ02G) and 2018 base case (Base18G) emission inventories. (In the final updates some of the source specific information was replaced with NEI data that moved sources to the center of the county, we are outlining that we need files that have the final CMAQ inventory and the location specific information).

   Deliverable: Upon completion, the Contractor shall provide the following to EPA R6: a memorandum documenting changes to the EI and the procedures used to make the updates to the EI.

   The Contractor shall obtain approval for this deliverable from EPA R6 prior to proceeding with the next step. It is expected that EPA will be able to approve the Contractor's memorandum within 3 business days of receipt.

c) Compare 2002 and 2018 final CENRAP inventories for EGUs with EGU inventories for the CSAPR and MATS 2011 rules (2005/2014 CSAPR and 2005/2016 MATS). Provide the following:
   i. Spreadsheets with EGU facility specific comparisons (unit based if available and not difficult – discuss with EPA).
   ii. Spatial plots of differences between EI and spatial plots of each EI timeframe (base and future years). The expectation is that while the years differ, the EGU inventories should be similar but must be compared before deciding on an EGU EI update strategy. Source specific information must be provided where possible for decision making on how to perform updates to the EI for EGUs.
   iii. A memorandum documenting proposed changes to EI and the procedures used to make the updates to the EI would be provided for the 2.c. task.

   Deliverable: Upon completion, the Contractor shall provide the following to EPA R6: a memorandum documenting the proposed changes to the EI and the procedures used to make the updates to the EI.

   The Contractor shall obtain approval for this deliverable from EPA R6 prior to proceeding with the next step. It is expected that EPA will be able to approve the Contractor's memorandum within 5 business days of receipt.

d) Based on input from EPA Region 6, update 2002 and 2018 EGU files as directed.

[1] Note: These are not the final Emission Inventory files used in the CMAQ modeling conducted for CENRAP states.

e) Modify emission inputs for Oil and Gas in North Texas area, based on recent modeling files available from TCEQ. EPA will provide an appropriate TCEQ contact.

f) Update Speciation profiles for CB-V.

Deliverable: Upon completion of Subtask 1.e and 1.f, the Contractor shall provide the following to EPA R6: a memorandum documenting the changes to the EI and the procedures used to make the updates to the EI.

TASK 2: Subtask 2. Conducting CAMx PSAT Source Apportionment Modeling.

For this Subtask, the Contractor shall:

Conduct 2002 and 2018 modeling with Plume-In-Grid and a 12 km flexi -nest grid that covers the area of the Class I areas (Eastern NM to Breton area and OK-KS border to Mexico border at southern tip of Texas).

For each of the 2002 and 2018 modeling runs that will be conducted, the Contractor shall provide the following to EPA R6: the associated post-processing conducted to generate information to evaluate RH projections and impacts from emission reductions at source identified. It is expected that this will include deliverables of initial modeling evaluations followed with modeling summary information provided as memos with associated data.

a) Run revised 2002 emission inventories and generate new base case RH modeling. EPA is interested in doing projections of visibility at a number of Class I areas impacted by Texas, including Wichita Mountains, Caney Creek, Upper Buffalo, Breton Island, Big Bend, Guadalupe Mountains, Carlsbad, Salt Creek Wilderness, and White Mountain. Final list will be shared during project and prior to start of Subtask 2.

Deliverable: Upon completion, the Contractor shall provide the following to EPA R6: the modeling summary information in the form of memo and summary data. This information will be used by EPA R6 for review and comparison with previous CENRAP final modeling base projections.

The Contractor shall obtain approval for this deliverable from EPA R6 prior to proceeding with the next step. It is expected that EPA R6 will be able to approve the Contractor's memorandum within 5 business days of receipt.

b) Conduct PSAT sensitivity runs on 2018, for sources/groups of sources based on a list provided by EPA Region 6. It is anticipated that EPA R6 will be able to provide this list within 5 business days of completion of the subtask 1. Sources with reductions will be a combination of elevated point sources and some lower level sources. Envision 3-5 future year model runs: 1 No additional controls. 2 & 3. High and low level controls on EGU and non-EGUs that EPA identifies, and runs 4, 5, 6 will be outlined later if we determine more sensitivity runs or a final scenario run are needed.

Deliverable: Upon completion, the Contractor shall provide the following to EPA R6: modeling summary information in the form of a memo and Future year visibility impairment projections at each Class I area, PSAT data and summary data This information will be used by EPA R6 for review and comparison with previous CENRAP final modeling base and future projections (memo would expand on documentation for Subtask 2.b).

The Contractor shall obtain approval for this deliverable from EPA R6 prior to proceeding with the next step. It is expected that EPA R6 will be able to approve the Contractor's memorandum within 5 business days of receipt.

TASK 2: Subtask 3. Report
Deliverables: Based on the information developed in Subtask 1 and 2 above, the Contractor shall provide the following to EPA R6, for each of the 2002 and 2018 cases:

a) DRAFT Report, including memorandums from subtasks as well as any additional documentation of process, changes to EI, etc.

b) Model run input, outputs, control files, visibility post-processing software, etc. (as electronic deliverables).

Upon receipt of draft versions of these deliverables, the EPA R6 WAM will provide comments within 10 business days.

The Contractor shall provide final work products, including a final version of the Report, within 10 business days following receipt of WAM comments.

TASK 3: Subtask 4: Comment Response Support

The Contractor shall not proceed with this subtask until directed through written technical direction by the EPA R6 WAM.

The Contractor shall provide technical support, as needed, to address approximately 3,000 – 5,000 public comments that are received on EPA's TX RH proposal, concerning Task 2, subtasks 1-3. EPA Region 6 will provide the Contractor with a copy of the comments in either Microsoft Word or Adobe pdf format, and the Contractor will provide a draft referenced response in Microsoft Word format.

Deliverable: The Contractor shall provide EPA R6 with a record of this work, including a description of the technical support provided; hours may be grouped together on like undertakings. This record shall be provided on a monthly basis, within 15 days following the end of each month.

Task 3: Control Cost and Performance Capability Support

Purpose: To support EPA Region 6 in assessing pollution control costs and the performance capability of those controls and in responding to public comments.

The results of this task will be reviewed and considered by EPA R6 as part of EPA R6's review and evaluation of the Texas RH State Implementation Plan (SIP).

Background: Task 2 is designed to evaluate the visibility impact of sources and the benefit of potential emission reductions from those sources on RH projections. Task 3 is designed to assess the costs and the performance level of any controls that could be installed on the sources identified from Task 2. It is envisioned that this task will primarily be concerned with the evaluation of SO_2 controls on coal fired EGUs, but a small number of other sources may also have to be evaluated for NOx and/or SO_2. Because of time constraints, part of Task 3 must begin prior to the completion of Task 2, and it is anticipated that all of Task 3 will be completed at a time similar to the completion of Task 2. This timing necessitates that the control cost and performance evaluation be performed on a broad group of sources that may significantly impact visibility.

To conduct this work, a proven national expert-level knowledge of stationary source pollution control costing and performance evaluation as applied to the regional haze program is required. It is anticipated that the contractor may need a subcontract in order to provide the needed expertise.

Description: EPA R6 will provide the Contractor a listing of potential significant sources of visibility impairing pollutants, including coal fired EGUs and potentially other large stationary sources. The Contractor shall provide support in the development of control costs and the performance capability of pollution control equipment for these sources, using the methodology described in EPA's Pollution Control Cost Manual.[2] This work will entail the identification of information and resources for costing controls, the potential development or modification of spreadsheet control cost models, and the assessment of the performance potential of the costed controls. The Contractor is expected to provide support to the EPA Region 6 staff in the development of an EPA report. The Contractor is also expected to provide support to EPA Region 6 in responding to comments received in response to EPA Region 6's proposed action on the Texas Regional haze SIP.

General Requirements. The Contractor shall provide EPA R6 with a record of this work, including a description of the technical support provided; hours may be grouped together on like undertakings. This record shall be provided on a monthly basis, within 15 days following the end of each month.

Schedule. Because of time constraints, it is planned that Task 3 will proceed concurrently with Task 2, necessitating that the control cost and performance evaluation be performed on a broad group of sources. This work shall be completed as soon as possible with the assessment of the performance potential of controls to be completed

[2] http://www.epa.gov/ttn/catc/dir1/c_allchs.pdf

first (as it is an input to Task 2), followed by the pollution control cost evaluation. This work shall be completed as follows:

Subtask 1	Within 4 weeks of the start of this subtask
Subtask 2	Within 12 weeks of the start of this subtask
Subtask 3	Within 4 weeks of the start of this subtask
Subtask 4	Within 3 weeks of the start of this subtask
Subtask 5	Within 12 weeks of the start of this subtask.

This work consists of the following sub-tasks:

TASK 3: Subtask 1: Assessment of the Cost and Performance Potential of EGU SO_2 Retrofit Controls

For this Subtask, the Contractor's duties shall consist of the following:

The Contractor will be provided with spreadsheet of cost analyses for SO_2 scrubber and Dry Sorbent Injection (DSI) retrofits for potentially significant sources of visibility impairing coal fired EGUs. This will include a unit-by-unit accounting of the latest SO_2 and NOx emissions and heat rate information, existing pollution controls, fuel type where available, location by latitude and longitude, and other pertinent information.

The Contractor shall check the information for accuracy and technical appropriateness, considering the task at hand. This shall include an assessment of the minimum achievable SO_2 emission limit that could result from the installation of scrubbers. This shall include an assessment of all parameters and assumptions. The Contractor shall provide appropriate documentation to support that assessment, which shall include manifestly defendable SO_2 emissions based on the best controlled of similar sources, for the particular control and fuel type.

Deliverable: The Contractor shall provide EPA R6 with a record of this work, including a description of the technical support provided; hours may be grouped together on like undertakings. This record shall be provided on a monthly basis, within 15 days following the end of each month.

TASK 3: Subtask 2: Assessment of the Costs and Performance of EGU Scrubber Upgrades

The Contractor shall not proceed with this subtask until directed through written technical direction by the EPA R6 WAM.

The Contractor shall assess existing resources (e.g., literature search, existing control cost models, any information supplied by EPA, etc.) for a methodology for costing scrubber upgrades and calculating the performance resulting from those upgrades. This analysis may be categorized into levels of increasing performance and cost. It is anticipated that this may involve approximately one dozen units as selected by EPA. This control cost

analysis is not expected to approach the specificity of EPA's Oklahoma and New Mexico FIPs. Rather, the Contractor will provide support in developing costing information that is based on the existing costs of similar controls from existing sources. All costing must follow EPA's Pollution Control Cost Manual. Discussions with pollution control vendors and the solicitation of quotes or other supporting material may be necessary in specific cases. For each unit assessed under Task 3, subtask 1, above, the Contractor shall provide support to EPA Region 6 in developing the capital cost, the annualized cost, the emission limit, and the cost effectiveness in terms of $/ton of pollutant removed. This analysis shall be in spreadsheet form.

Deliverable: The Contractor shall provide EPA R6 with a record of this work, including a description of the technical support provided; hours may be grouped together on like undertakings. This record shall be provided on a monthly basis, within 15 days following the end of each month.

TASK 3: Subtask 3: Comment Response Support

The Contractor shall not proceed with this subtask until directed through written technical direction by the EPA R6 WAM.

The Contractor shall provide technical support, as needed, to address public comments that are received on EPA's TX RH proposal, concerning Task 3, subtasks 1 and 2. EPA Region 6 will provide the Contractor with a copy of the comments in either Microsoft Word or Adobe pdf format, and the Contractor will provide a draft referenced response in Microsoft Word format.

Deliverable: The Contractor shall provide EPA R6 with a record of this work, including a description of the technical support provided; hours may be grouped together on like undertakings. This record shall be provided on a monthly basis, within 15 days following the end of each month.

TASK 3: Subtask 4: General Control Cost and Performance Capability Support

The Contractor shall not proceed with this subtask until directed through written technical direction by the EPA R6 WAM.

The Contractor shall provide general technical support on control cost and performance capability, as needed, as directed by EPA.

Deliverable: The Contractor shall provide EPA R6 with a record of this work, including a description of the technical support provided; hours may be grouped together on like undertakings. This record shall be provided on a monthly basis, within 15 days following the end of each month.

TASK 3: Subtask 5: Assessment of the Costs and Performance of EGU Scrubber Upgrades Using Claimed Confidential Business Information (CBI)

The Contractor shall not proceed with this subtask until directed through written technical direction by the EPA R6 WAM.

The Contractor shall consider claimed Confidential Business Information (CBI) in relation to a methodology for costing scrubber upgrades and calculating the performance resulting from those upgrades. The Contractor shall use claimed CBI to provide support in developing costing information that is based on the existing costs of similar controls from existing sources. All costing must follow EPA's Pollution Control Cost Manual.

Deliverable: The Contractor shall provide EPA R6 with a record of this work, including a description of the technical support provided; hours may be grouped together on like undertakings. This record shall be provided on a monthly basis, within 15 days following the end of each month.

TASK 4: Comment Response Support

The Contractor shall not proceed with this task until directed through written technical direction by the EPA R6 WAM.

The Contractor shall not proceed with any subtasks until directed through written technical direction by the EPA R6 WAM.

The Contractor shall provide support to address public comments that are received on EPA's TX RH regulatory proposal.

For public comments received by EP in response to the regulatory proposal, the contractor shall perform the following:

- Subtask 1: Review, index, organize
- Subtask 2: Summarize
- Subtask 3: Provide technical support in the development of draft responses
- Subtask 4: Provide technical analysis as needed to develop such responses
- Subtask 5: Provide modeling analysis as needed to develop such responses.

Deliverable: The Contractor shall provide EPA R6 with a record of this work, including a description of the technical support provided; hours may be grouped together on like undertakings. This record shall be provided on a monthly basis, within 15 days following the end of each month.

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-09

☐ Other ☒ Amendment Number: 000001

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016 Base Option Period Number 4	Texas Regional Haze Evaluation

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 2,3,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
This amendment is to issue a STOP WORK on this work assignment.

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

	Cost/Fee:	LOE:
Contract Period: 04/01/2011 To 03/31/2016		
This Action:		
Total:		

Work Plan / Cost Estimate Approvals

	Cost/Fee	LOE:
Contractor WP Dated:		
Cumulative Approved:		

Work Assignment Manager Name: Wendy Jacques (Signature) (Date)	Branch/Mail Code: Phone Number: 214-665-7395 FAX Number:
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5256 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Marsha B. Johnson (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-0952 FAX Number:

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-09

☐ Other ☒ Amendment Number: 000002

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 09/30/2016 Base Option Period Number 4	Texas Regional Haze Evaluation

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: 2,3,15,16,17

Purpose:
- ☐ Work Assignment
- ☒ Work Assignment Amendment
- ☐ Work Plan Approval
- ☐ Work Assignment Close-Out
- ☐ Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:
Two actions: (1) change signature line in EAS for current RTPPOD Specialist; (2) inform Contractor that hours/cost will be decreased to what actually used (decrease from 645 hours to 509 hrs/Cost_Fee decrease from $108,879 to $82,671).

☐ Superfund — Accounting and Appropriations Data — ☒ Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

Contract Period: 04/01/2011 To 09/30/2016 — Cost/Fee: — LOE:

This Action:

Total:

Work Plan / Cost Estimate Approvals

Contractor WP Dated: — Cost/Fee — LOE:

Cumulative Approved: — Cost/Fee — LOE:

Work Assignment Manager Name: Wendy Jacques (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	214-665-7395
	FAX Number:	
Project Officer Name: Carolyn Blake (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5256
	FAX Number:	
Other Agency Official Name: Judy Ancharski (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-5586
	FAX Number:	
Contracting Official Name: Andrew Flynn (Signature) (Date)	Branch/Mail Code:	
	Phone Number:	919-541-2674
	FAX Number:	919-541-0611

EPA

United States Environmental Protection Agency
Washington, DC 20460

Work Assignment

Work Assignment Number: 4-10

☐ Other ☐ Amendment Number:

Contract Number	Contract Period	Title of Work Assignment/SF Site Name
EP-W-11-029	04/01/2011 To 03/31/2016	Co-Benefits Calculator
	Base X Option Period Number	

Contractor: RESEARCH TRIANGLE INSTITUTE

Specify Section and paragraph of Contract SOW: Sections 4, 7, 8, 14

Purpose:
- [X] Work Assignment
- [ ] Work Assignment Amendment
- [ ] Work Plan Approval
- [ ] Work Assignment Close-Out
- [ ] Incremental Funding

Period of Performance: From 04/01/2015 To 03/31/2016

Comments:

WA 4-10 Full Title: Co-Benefits Calculator

This WA continues work on WA 3-10. See attached SOW. 300 hours are included for preparation of the work plan and to begin working on the work assignment.

☐ Superfund — Accounting and Appropriations Data — [X] Non-Superfund

Note: To report additional accounting and appropriations date use EPA Form 1900-69A.

SFO (*Max 2*) ☐

Line	DCN (Max 6)	Budget/FY (Max 4)	Appropriation Code (Max 6)	Budget Org/Code (Max 7)	Program Element (Max 9)	Object Class (Max 4)	Amount (Dollars)	(Cents)	Site/Project (Max 8)	Cost Org/Code (Max 7)
1										
2										
3										
4										
5										

Authorized Work Assignment Ceiling

	Contract Period:	Cost/Fee:	LOE:
This Action:	04/01/2011 To 03/31/2016		
Total:			

Work Plan / Cost Estimate Approvals

Contractor WP Dated:	Cost/Fee:	LOE:
Cumulative Approved:	Cost/Fee:	LOE:

Work Assignment Manager Name: Amanda CurryBrown (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3808 FAX Number:
Project Officer Name: Jolynn Collins (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-5671 FAX Number:
Other Agency Official Name: (Signature) (Date)	Branch/Mail Code: Phone Number: FAX Number:
Contracting Official Name: Rodney-Daryl Jones (Signature) (Date)	Branch/Mail Code: Phone Number: 919-541-3112 FAX Number:

Statement of Work

I. Title: Refining Ecosystem Services Approaches Relevant to Restoring the Chesapeake Bay

Contractor Name: RTI
Contract #: EPW11-029
WA #: 4-21

II. Work Assignment Manager (WAM):

WAM Name: Naomi Detenbeck
U.S. Environmental Protection Agency
National Health and Environmental Effects Research Laboratory
27 Tarzwell Drive
Narragansett, RI 02882
Phone: (401) 782-3162

Alt. WAM Name: Marnita Chintala
U.S. Environmental Protection Agency
ORD / NHEERL/AED
27 Tarzwell Drive
Narragansett, RI 02882
Phone: (401) 782-3155

III. Background:

Using an Executive Order to restore the Chesapeake Bay as an overarching framework, ORD undertook a project to explore the cost-effectiveness and the legal and social feasibility of innovative policies and institutional arrangements that could allow markets or market-like mechanisms to reduce the costs of meeting the Total Maximum Daily Loads (TMDLs) for nitrogen, phosphorus and sediment required under the Order, while at the same time promoting the creation or restoration of "bonus" ecosystem services (those not related to water quality in the Bay).

An optimization analysis framework was developed to test alternative policy scenarios. The model minimizes the costs of a mixture of "gray" and "green" infrastructure practices needed to meet the three TMDLs, while estimating the levels of several bonus ecosystem services supplied for each unit of the practice adopted. Examples of these ecosystem services include greenhouse gas reductions and carbon sequestration (climate stabilization); recreational hunting, fishing and birding; reduced risk of floods, droughts, and salinity intrusions, and removing air pollutants harmful to human health. The model was used to examine the effects of various regulatory and incentive policy scenarios on the costs of achieving the TMDLs and the bonus ecosystem services delivered.

Results indicated that a least-cost solution to simultaneously meeting the preliminary nutrient and sediment loading targets established by the TMDL include substantial

contributions from cropland retirement, and restoration or creation of wetlands in both farm and developed land settings. The extent of wetlands suggested by the model is far in excess of the current EO strategic targets. This solution would generate significant social benefits from greenhouse gas credits, increased duck and brook trout habitat (both goals of the Executive Order), hunting opportunities, water storage during extreme rainfalls, and enhanced water holding capacity of soils. The model has shown that policies such as restricting point/non-point source water quality trading until wastewater treatment plants are fully upgraded to meet state-of-the art effluent limits, requiring 2:1 offsets for WWTP-BMP trades, or prohibiting trading if it takes a significant amount of farmland out of production greatly increase the costs of both improving water quality in the Bay and delivering the other ecosystem service co-benefits.

A series of webinars was held to describe the analysis methods and as a result of that effort and release of the final report in 2012, the approach has gained considerable attention as a means to understand the potential for trading and offsets to reduce the costs of TMDL. The framework has proven to be valuable for providing insights into how policies may foster or impede various goals. Subsequently, the past work has been leveraged to provide policy insights, including options for nutrient trading policies. This work assignment has two major objectives: (1) to extend and verify the quantification of upstream benefits of nutrient and sediment reductions within the Chesapeake watershed; (2) to adapt or modify the modeling system so that it can be incorporated into the Chesapeake Community Modeling Program (CCMP) suite of models.

IV. Description and Tasks:

The EPA WAM will review all deliverables in draft form and provide revisions and/or comments to the contractor. The contractor shall prepare the final deliverables incorporating the EPA WAM's comments.

Task #1: Work Plan and Demonstration of RTI QA/QC system

The Contractor shall develop a new work plan. The Contractor shall hold conference calls with the WAM on at least a monthly basis after approval of the work plan to plan and review progress of this WA. In lieu of a contract-level Quality Management Plan, the Contractor shall provide a response to the questions included in "Respondent Requirements demonstrating their organization's Quality Assurance and Quality Control System" (attached), which should be included in the work plan.

Task #2: Quality Assurance Plan

The Contractor shall develop a quality assurance plan to cover any activities in this work assignment that involve the collection, generation, use and/or reporting of environmental data or development of software and/or models prior to beginning data analysis.

Task #3: Upstream Benefits Assessment Report Revisions

The Contactor shall complete revisions to the report entitled "Ecosystem Services and Environmental Markets in Chesapeake Bay Restoration" in response to EPA and reviewer comments (received during past option period for WA 3-21). The contractor shall also provide any revisions needed during final report formatting for publication as an EPA report (e.g., improved resolution figures if needed).

Task 4: Tool Development

Under previous WA 3-21, the contractor developed options for integrating an optimization tool into CAST, an existing decision support tool for the Chesapeake Bay TMDL (Memo from RTI to EPA dated 2/13/15 entitled "Options for Integrating an Economic Optimization Tool into the Existing Chesapeake Bay TMDL Decision Support Tools"). Based on feedback received from EPA, including the Chesapeake Bay Program Office, the Contractor shall develop and test simple versions of the two approaches proposed using data for a single county and a subset of main BMPs included in CAST to better evaluate and compare their potential performance in a broader application. The contractor shall focus on two general approaches.

1. Linear optimization using the General Algebraic Modeling System (GAMS)
2. Linear or nonlinear optimization using a genetic algorithm (GA) approach

as well as considering combined or two-stage approaches for streamlining the optimization process. For example, after a set of mutually exclusive BMP options are defined for specific land use categories in specific LRsegs and the costs and load reductions for each option are determined, it may be useful as a first stage to screen out and eliminate "dominated" options. An option is dominated if there is at least one other option available that can achieve the same or larger load reduction for the same or lower cost. In the second stage, the remaining options (i.e., those that constitute the "cost-efficient frontier") would be retained for optimization analysis.

A GA can be developed to produce this cost-efficient frontier and establish the set of eligible BMPs. This information would directly feed the GAMS-based optimization model, which would then select the optimal portfolio of BMPs given the policy input parameters initiated by the user. A hybrid approach that uses GA for the first stage and GAMS for the second might improve the efficiency of the optimization strategy while capturing the benefits of an optimization-derived solution.

Following completion of these tests, the contractor shall provide a brief report documenting the methods applied, results obtained, optimization tool QA/QC checks, and recommendations for scaling up either the GA, GAMS or combined approaches to the full Chesapeake Bay watershed and full suite of BMPs included in CAST. The report shall also include copies of coding used to perform the tests with associated code documentation.

V. QA Requirements:

See Tasks 1 and 2 above.

VI. Deliverables:

The Contractor shall adhere to the following schedule:

Task	Deliverable	Delivery Schedule
1	Work Plan	20 days after effective date of WA
2	Quality Assurance Plan	30 days after effective date of WA
3	Deliverable	4 weeks after effective date of WA
4a	Deliverable: Report	8 weeks after effective date of WA
4b	Deliverable: Response to EPA comments	1 week after receiving comments from EPA

VII. Reporting Requirements:

The Contractor shall provide monthly progress reports in accordance with the terms of the contract. The Contractor shall submit work products in electronic as well as hard copy form. In addition, the Contractor shall deliver to the WAM each draft and final report in electronic format that is readable by windows-based word-processing (Microsoft Word 2003), graphics (Microsoft PowerPoint 2003), spreadsheet (Excel 2003), and database (Access 2003) programs. The Contractor shall also provide electronic copies of reports in PDF format.